Locomotive Power

How Professor Dalby Calculates It

THE excellent address prepared by Prof Dalby as president of Section G, at the last meeting of the British Association, has not received the attention it deserved. The audience was scanty although the subject was attractive— British Railways Some Facts and a Few Problems. The address as a whole was not delivered; but Prof. Dalby talked about it, and received a vote of thanks There was no discussion although it presented many points for argument and careful consideration Its interest lies principally in the comparison drawn between railway working in the present day and in 1840 A dozen examples might be picked out in a few minutes. Thus for instance Prof Dalby tells us that the gross receipts of the London and North-Western Railway in 1908 were twenty two and a half times as much as those of the London and Birmingham Railway in 1840 and that the track mileage open was about twenty two times as great. The money earned per mile of track open is thus practically the same after a lapse of seventy years To earn the same amount per mile of track open however the trains of the London and North Western Railway had in 1908 to run 68 8 times the number of train miles that the trains of the London and Birmingham Railway ran in 1840 That is to say in order to earn a sovereign a London and North Western train has now to run three times the distance which it was necessary for a London and Birmingham train to run to earn the same amount.

The most interesting portion perhaps of the address concerns the power exerted by locomotive engines in hauling fast trains Here Prof Dalby entered on highly debatable ground He calculates the power in terms of tons of total load including engine and tender speed and train resistance He takes the Scotch express—Euston to Edinburgh—and he reduces his calculations to the form of a diagram Typical trains he tells us weighed in 1864 1885 and 1903 respectively 100 tons 250 tons and 4 0 tons The average speed in 1864 was 40 miles per hour in 1885 45 miles and in 1903 about 52 miles per hour The engine powers were 100 400 and 1 000 horse Precisely what the word power means we are not certain but we gather that it is not the indicated power but that obtained by multiplying the weight by the resistance and the velocity in feet per minute divided by 33 000 which gives a result less than the indicated power by the amount required to overcome the internal friction of the machinery We do not think that the load was ever so small as 100 tons in 1864 The work was largely done by the 'Problem or Lady of the Lake class with outside cylinders and 7 foot 6-inch wheels. These engines weighed full about 30 tons and the tender 18 tons or say 48 tons which left a very small proportion for the train proper if the total was only 100 tons During the race to the north in 1888 the train consisted of four coaches weighing 80 tons But while we believe that Prof Dalby underestimated the power required in 1864 we are equally certain that he overestimates it for 1903 No locomotive has yet been made for working express trains in this country which will continuously exert 1 000 horse-power between Euston and Edinburgh or Euston and Carlisle It must not be forgotten that the power as stated by Prof Dalby is that required to maintain speed on a level He bases his calculations on the formula $T = 5\,1/3 + \frac{V^2}{256}$ where T is the tractive effort. Thence he deduces that horse-power developed at the driving wheels is—

$$H\ P = W\left(\frac{V}{70} + \frac{V^3}{96\,000}\right)$$

We do not know where Prof Dalby got his resistance formula There are of course a great number from which to select but that which he has chosen is much too high Sinclair deduced from tests made on the New York Central and Hudson River Railroad

$R = 2 + \frac{V}{4}$ The Baldwin Locomotive Works use

$R = 3 + \frac{V}{6}$ M Laboriette s French experiments gave

$R = 3\ 2[illegible] + \frac{V^2}{281}$ Mr Deeley on the Midland arrived

at $R = 3 + \frac{V^2}{290}$ If we take Laboriette we get for [illegible]2 miles an hour 12 3 pounds per ton and for Deeley 11 8 pounds Let us take the round number 12 pounds and we have for 4 0 tons a gross steady tractive effort on the level of [illegible] 400 pounds Now [illegible]2 miles an hour is 4[illegible]76 feet per minute and $\frac{4[illegible]6 \times [illegible]400}{33\,000} = 749$ H P or 75 per cent of the power stated by Prof Dalby—a not unimportant difference It is well to remember that in the conduct of railway traffic it is the last straw that breaks the camel s back While a big engine may develop 700 horse power with ease and economy to get 1 000 out of it may involve much waste and wear and tear and the extreme probability that the driver and fireman having nothing in hand will fail to keep time with punctuality

Prof Dalby asks the very pertinent question What is the maximum power that can be obtained from a locomotive within the limits of the construction gage on British railways? This of course refers to engines of norm[illegible] [illegible]ster double engines [illegible] [illegible]uth America by the [illegible] [illegible] Newton le Willow[illegible] [illegible]ing the question [illegible] [illegible] a large number of [illegible] [illegible] that if the indicated horse-power be plotted against the rate at which heat energy is transferred across the boiler heating surface the points fall within a straight line region providing that the regulator is always full open and that the power is regulated by means of the reversing lever He has prepared a diagram setting this out graphically The diagram indicates that the indicated horse-power is practically proportional to the rate at which heat is transferred across the boiler heating surface and as this is again proportional to the extent of the heating surface, the limit of economical power is reached when the dimensions of the boiler have reached the limits of the construction gage the boiler being provided with a fire grate of such size that at maximum rate of working the rate of combustion falls between 70 pounds and 100 pounds of coal per square foot of grate per hour A boiler of large heating surface may be made with a small grate necessitating a high rate of combustion to obtain the required rate of heat production Then although a large power may be obtained it will not be obtained economically

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We confess that this proposition puzzles us Ostensibly it quite ignores the way in which the steam is used The units transmitted produce the same quantity of steam per unit no matter at what rate the transfer proceeds and the weight of steam is the measure of the power of the locomotive no matter in what way it is used But it seems to be obvious that if an engine is taking steam for 80 per cent of its stroke it will require a greater weight per horse-power per hour than it will if the valve gear is cutting off at 60 per cent which is of course contrary to Prof Dalby If he is right then an invariable relation exists in every locomotive other things being equal between the quantity of coal put into the fire-box and the horse power of the engine Indeed he expressly states that waste is represented by sparks ejected from the chimney and that the change in efficiency is small notwithstanding large changes in the indicated horse power Our readers will we feel sure agree with us that this is a very remarkable proposition as it stands It certainly comes as a discovery for so far as we are aware no one has ever hinted at the existence of an invariable relation between the quantity of coal put into a boiler furnace and the power got out of the steam resulting from its combustion It has of course long been known that the power depends on the quantity of coal burned Some years ago Mr Wolff in his book Modern Locomotive Practice put this very tersely by saying that at high speeds the maximum horse power a locomotive can exert is practically a constant being determined by the amount of water the boiler can evaporate If this were what Prof Dalby means then he would not have claimed to have made a discovery Perhaps Prof Dalby will favor us and our readers with a correction quite necessary if we have failed to understand him

It is worth while to give a few figures showing what must take place in a locomotive working up 1 000 indicated horse power The weight of steam required will be about 25 pounds per horse per hour or a total of 25 000 pounds To evaporate this would demand at least 3 500 pounds of coal The grate area is about 22 square feet in the engines of which Prof Dalby speaks Therefore to burn 3 500 pounds of coal per hour nearly 160 pounds must be burned in the same time per square foot which at 52 miles an hour means a consumption of about 70 pounds of coal per train mile Nothing approaching these figures obtains continuously on any English railway That a big modern engine can be made to indicate considerably over 1 000 horse power for short spurts is quite well known but this is a very different thing from a continuous effort such as Prof Dalby appears to have had in mind —The Engineer

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The Effect of Silver Bismuth and Aluminium on the Mechanical Properties of "Tough-Pitch Copper Containing Arsenic

BEFORE the Institute of Metals Mr F Johnson stated that he melted electrolytic copper in a crucible and added the desired quantity of arsenic in the form of an alloy of arsenic and copper then the pure metallic silver bismuth or arsenic was added the metal well stirred and samples poured from time to time till the flat surface of the solidified ingot showed that the metal was at tough pitch An ingot 6½ by 1¼ by 1¼ inches was then cast in an open chill mold, reheated to a bright red heat and rolled to a rod 4 feet long by ½ inch diameter From these rods pieces were cut for the mechanical tests (bending, alternating stress malleability and tensile [illegible]) and for chemical analysis The chief results [illegible] follows All the 'tough-pitch samples contain[illegible] arsenic (0.26 to 0 52 per cent) show improved [illegible]chanical properties over the "tough pitch pure [illegible] similarly treated. The presence of arsenic [illegible] the percentage of oxygen needed to bring the [illegible] to "tough-pitch." After hot-rolling, quench[illegible] [illegible] greater toughness on the bars than slow [illegible] [illegible] up to 0.1[illegible]5 per cent in presence of [illegible] [illegible] the hot-working properties [illegible] [illegible] and raises the elastic limit It does not seem to influence the tough pitch stage Bismuth is detrimental even in presence of arsenic but as much as 0 05 per cent with 0 3 to 0 4 per cent of arsenic is not ruinous Hot working improves the metal containing bismuth for further mechanical treatment The effect of bismuth is to raise the tensile strength and extensibility but to lower the elastic limit and resistance to alternating stress It causes more oxygen to be required to reach tough pitch 'Tough pitch pure copper with 0 02 per cent of bismuth is much worse mechanically than tough pitch arsenical copper with 0 05 per cent Aluminium added to tough pitch arsenical copper so as nearly to deoxidize it (0 014 per cent) does not affect its hot working properties but lowers its tensile strength while increasing its toughness and ductility Excess of aluminium however (0 3 to 0 4 per cent) is disastrous to the hot-working properties of the metal and impairs its mechanical properties in the rolled condition Microscopic examination shows that bismuth separates out from copper containing it, on solidification in elongated plates or crystals which separate the crystals of copper from one another Excess of oxygen appears to cause the bismuth to separate either as metallic globules or as irregular masses of a bismuth oxide, which have not the same effect in weakening the structure as the long streaks of bismuth in copper containing no oxygen.

In an address in geography before the British Association for the Advancement of Science Prof A J Herbertson in the Geographical Section reviewed the progress of the science and in the course of his remarks urged the need of establishing a government Hydrographical Department The absence of such a department would be recognized as serious if they considered how their water supply was limited and how much of it was not used to the best advantage He also argued that the information which many government departments were accumulating would become much more valuable if it were discussed geographically and if statistics were mapped and not merely set out in columns of figures Many Blue-books would be made interesting and more widely used if their facts were properly mapped

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Some of the plants of the family *Cruciferæ* which grow in pastures are distinctly poisonous Among these dangerous plants are various species of mustard The field mustard or charlock which is very common in many parts of France is particularly dangerous The black mustard appears to be less irritant but it is not free from poisonous qualities Its seeds seriously affect the health of cows and make their milk unwholesome The white mustard is still less poisonous, but not entirely innocent

Modern Governing Mechanisms

A Review of American and European Devices

By Warren H Miller

Of the various governing systems used by European and American builders of gas engines and means for varying the explosion pressure and consequently the mean effective pressure may be classified as follows

1 Constant volume of charge and variable ratio of gas to air

2 Constant ratio of gas to air and variable volume of charge

3 Variable ratio of gas to air and variable volume of charge

For small engines means for simply varying the stroke of the inlet valve will answer for regulation by varying the quantity of a constant ratio mixture and this is used in the original Deutz gears illustrated in Fig 1 The governor alters the position of the fulcrum of the inlet valve lever *I* and thereby changes the stroke of the inlet valve In large engines however it is usually not practical to depend on the stroke of the inlet valve alone to determine the quantity of mixture admitted without imposing too much work on the governor and robbing it of its sensitiveness or else incurring the liability of the valve to reopen under the suction when only light charges are to be admitted For this reason nearly all the large governor mechanisms include a mixing valve through which the governor controls the mixture in addition to the main inlet valve for admitting the charge to the cylinder and keeping it there Fig 2 illustrates the Deutz mechanism used on large engines the engraving being made from a drawing of the 2 000 horsepower size The governing is by throttling and the volume admitted is controlled as in the small engine by means of the movable fulcrum shifting the fulcrum *f* alters the stroke of a pair of balanced gas and air valves and the fulcrum at the left of the air valve spindle is also shifted still farther altering the opening of the gas valve The ratio of gas and air can be altered to suit the quality of gas by turning a handwheel which moves a sliding cage on the inlet valve stem

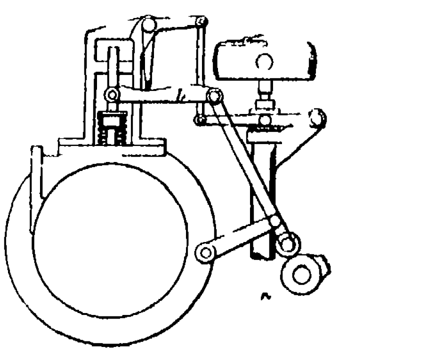


Fig 1 —ORIGINAL DEUTZ MOVABLE FULCRUM GEAR

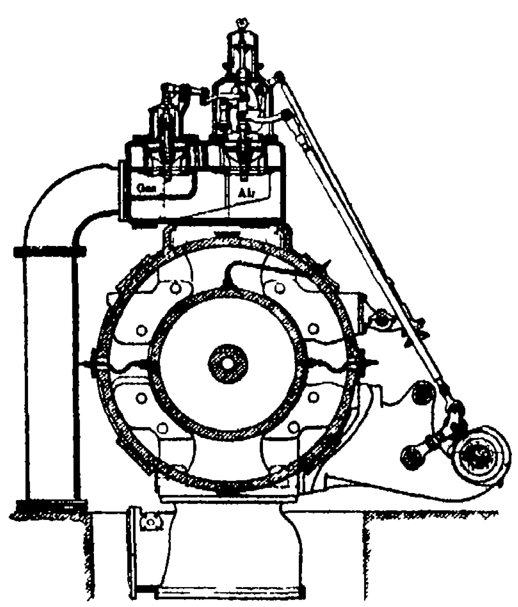


Fig 2 —DEUTZ VALVE GEAR FOR LARGE ENGINES

Fig 3 shows the form of shifting fulcrum gear devised by the Nürnberg company for varying the opening of the inlet valve The governor shifts the roller *R* and thereby varies the leverage of both the rocker arm *A* and the valve lever *L*

Fig 4 illustrates the cut-off governor gear of the Société Alsacienne It is somewhat similar to some of the American mechanisms in that it embodies a ported-cage mixing valve The inlet valve has a constant lift. The mixing valve shown in section in Fig 5 is a sliding cylinder with ports registering with ports in the housing which open into the gas and air mains It is divided circumferentially into air and gas ports in the correct ratio for the quality of gas used This valve remains normally down shutting the ports as shown in Fig 4 With each stroke of the eccentric rod operating the inlet valve the valve is lifted until the ports register with those in the housing and latched in that position allowing gas and air to flow through to the cylinder until the valve is released by a trip gear under the control of the governor when the latch is tripped the valve drops shutting the ports

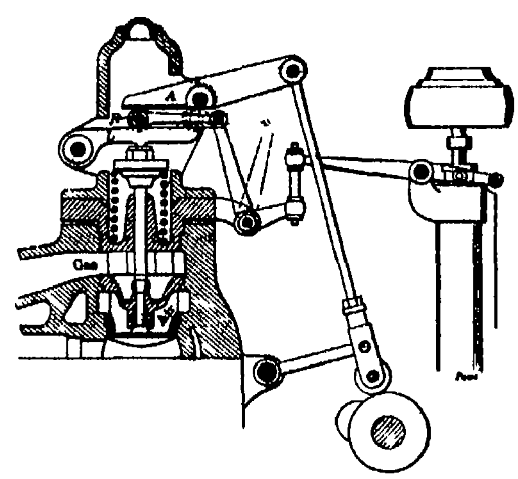


Fig 3 SCHMITZ MOVABLE FULCRUM GEAR

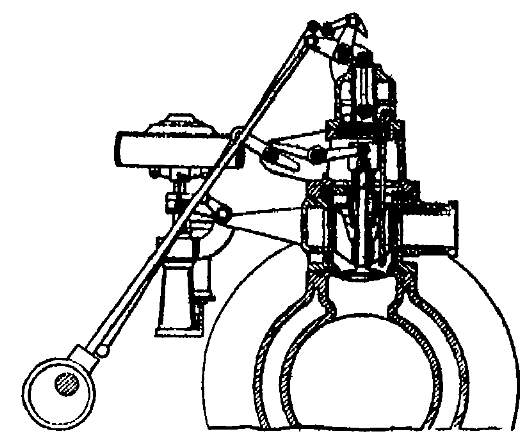


Fig 4 —ALSACIENNE VARIABLE CUTOFF GEAR

Fig 6 shows the mixing-valve gear used on the large size of the Nürnberg engine which is probably more familiar to American engineers than any other Continental engine Air is admitted throughout the suction stroke and the gas is admitted toward the end of the stroke both being shut off simultaneously at the end of the stroke The quantity of gas admitted is varied by opening the gas valve earlier or later in the stroke regulation is effected therefore by varying the quality of the mixture the volume being constant Fig 6 shows only the mechanism that operates the mixing-valve of which there is one on each cylinder placed midway between the two inlet valves which have constant lift and are opened by the usual cam rod lever combination A bifurcated arm *A* is pivoted at its fork ends to the outer housing and linked at the other end to one end of the bell crank *R* which is controlled by the governor The valve-operating lever *B* is pivoted at its inner end to the cylindrical member *C* which slides within another cylinder *E*, attached to the stem *S* of the valve, the lever *B* has a sort of rolling fulcrum on the arm *A*, and when the governor lowers the outer end of this arm, the "heel" of the lever *B* strikes the arm of the arm *A* later in the stroke and therefore opens the valve later and reduces the explosive mixture. The lever *B* opens the valve by lifting the sleeve *E* through the medium of a dog *D*, pivoted to the plunger *C* and this dog is tripped at the end of the suction stroke no matter at what point the valve is opened When the dog is tripped the valve is closed by the helical springs in the bonnet

The governor gear of the John Cockerill Company of Seraing Belgium also belongs to the variable-quality constant volume class but the mechanism is so designed that it can be used for either quantity or quality regulation Fig 7 shows longitudinal and transverse sections of the Cockerill engine cylinder and the principal features of the valve gear

The inlet valve has constant stroke and a sliding air valve moves with it so as to admit air synchronously with the opening of the inlet valve The gas valve is mounted above the air valve on a concentric sleeve and its actuating lever *L* is normally latched at the outer end by the dog *D* When the push rod *R* is forced upward by the inlet cam it opens the inlet valve and at the same time compresses a spring in the housing *S* which is attached to the lever *L* This would open the gas valve but for the latch *D* and this latch is tripped by the governor sooner or later in the stroke allowing the spring at *S* to open the valve The valve is closed at the end of the stroke by the downward motion of the housing *S* due to the fall of the push rod *R* when released by the main cam

The tripping rod *T* is moved back and forth by a small eccentric on the main shaft and its engagement with the dog *D* is timed by the governor through a mechanism which shifts the pivot of the intermediate rocker arm.

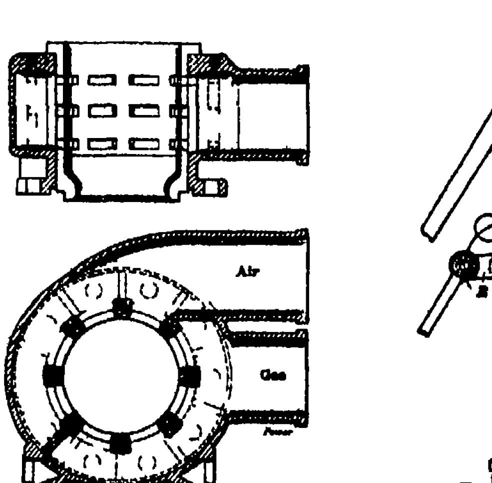


Fig 5 —ALSACIENNE MIXING VALVE

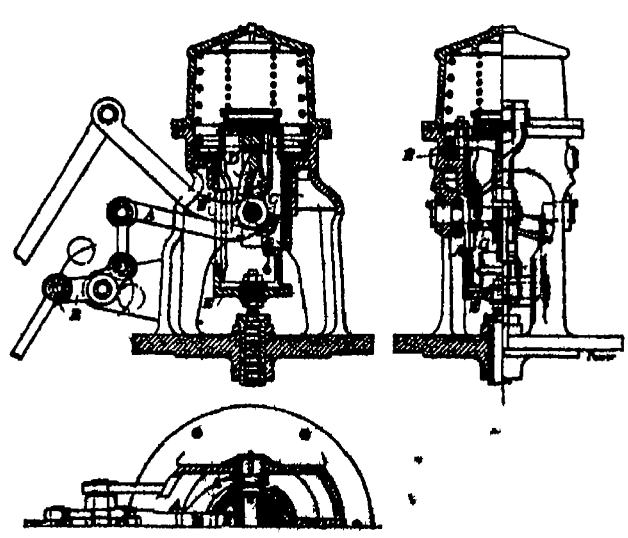


Fig 6 —NÜRNBERG VARIABLE CUTOFF GEAR

By extending the hollow spindle of the gas valve downward unpinning the air valve from the inlet valve stem and attaching it to the gas-valve spindle, the gear can be changed to quantity regulation.

A very [illegible] English gear operating on the variable-quality constant-volume plan is that of [illegible] shown in Fig. [illegible] [illegible]

* Power and the Engineer

lever system opens the inlet valve against a spring. The nut *M* on the inlet-valve stem tends to carry the gas-valve down with the inlet valve by compressing the spring *K*. The gas-valve disk *G* carries an upward cylindrical extension *H* which terminates in a vacuum piston *P* and incloses the spring *K*. A protected opening *O* allows air to pass in and out of the space below the piston *P* and a check valve *N* prevents the entrance of air above the piston but allows the escape of any that may be there. A bleeder valve *J* controlled by the governor allows more or less air to enter the vacuum cylinder and vary the upward pull of the piston *P*. When the spring *K* is compressed by the downward movement of the inlet valve, it presses the gas valve open more or less according to the amount of air admitted by the valve *J* and the resulting degree of vacuum that a given downward movement of the piston *P* can form above it.

As all of the American gears excepting that of the Bethlehem Steel Company's engine have been fully described in Power there is no need to discuss any but the Bethlehem gear in this article. Fig 9 is a sectional elevation of the mixing valve cage and shows also the inlet and mixing valves and the immediate operating mechanism. In this gear the ported cylinder attached to the inlet-valve stem which was first used in this country on the Westinghouse engine has been applied but the ports are cut diagonally. This makes it possible for the governor to control both the area of the port openings and the length of time that they are open without using trips or cutoffs. The sleeve *S* is twisted about the vertical axis by the governor rod and the relative angular positions of the same amounts of gas and air. When the load lightens, the governor shifts the sleeve *S* around so that at each stroke the ports in the sleeve and those in the plunger overlap less and less until at very light loads they register only during the latter part

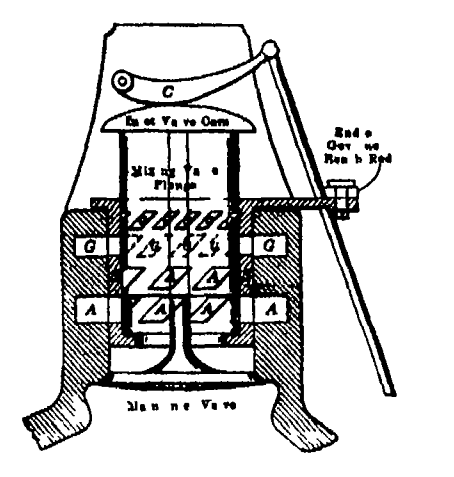


FIG 9 BETHLEHEM MIXING AND INLET VALVE AND CAGE

of the stroke. As the ports are very wide and slant at a considerable angle the governor has a very long selective range the total movement in an 800-horse power engine being about 3 inches on the surface of

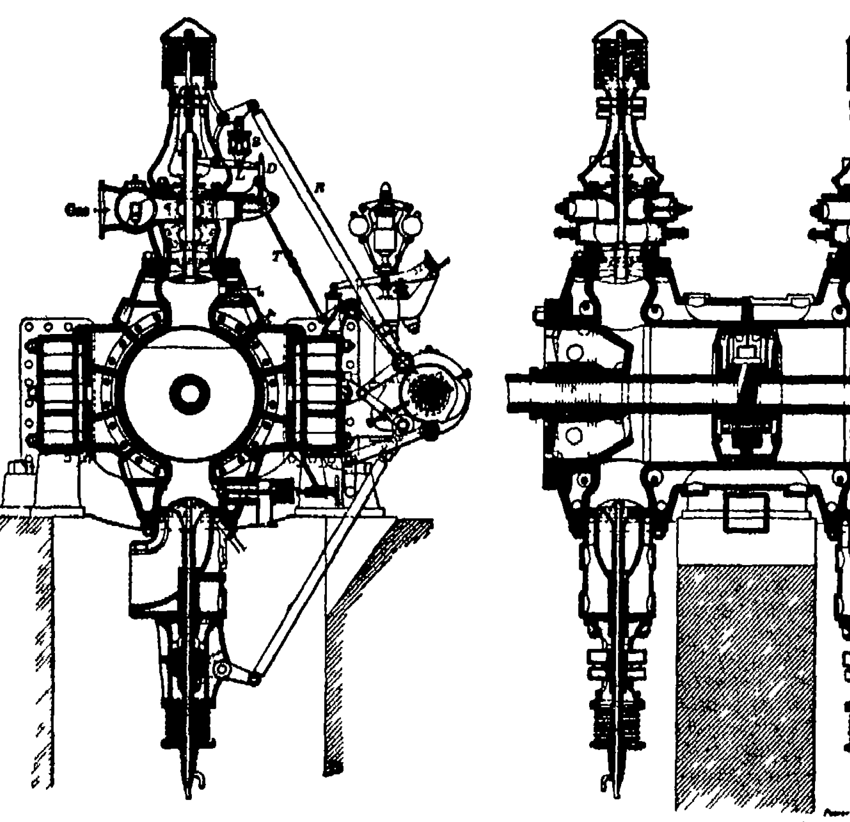
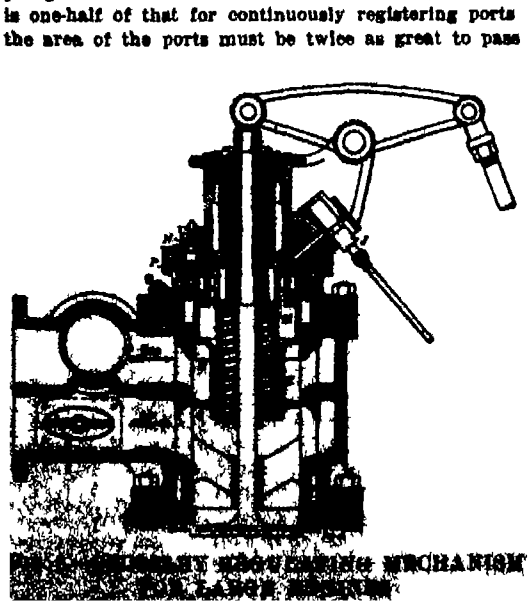


FIG 7—VALVE MECHANISM OF THE COCKERILL ENGINE

its ports and those in the mixing valve plunger are thereby varied. The mixing valve plunger is attached to the upper end of the inlet-valve stem and moves up and down with invariable stroke under the pressure of the cam *C* and the usual seating spring, which is not shown here. At full load the ports in the housing sleeve register completely with those in the plunger and since the total time that they connect is one-half of that for continuously registering ports the area of the ports must be twice as great to pass the sleeve and 7 inches at the pin on the outer end of the arm.

This gear is the latest one that has been developed in American practice and both this and the Westinghouse gears constitute an advance over English gears up to the present time in that they provide a variable cutoff without the use of any complicated trip arrangements or multiplicity of levers links cams etc.



GOVERNING MECHANISM ... LARGE ENGINE

The Sterilization of Milk

By Dr M Seiffert

The unsanitary and economically defective method of transporting milk in cans and pouring it repeatedly before it reaches the vessel of the consumer is still in general use. In this way the milk is exposed to contamination of many kinds and the visible impurities which it collects are not the least dangerous ones. The employment of cans for the transportation and sale of milk is also open to the objection that even when no fraud is intentionally practised by the dealer one customer may receive milk which contains much more than the normal proportion of cream, while another receives what is virtually skim milk. Unfortunately however the bottles and the method of sealing them which are now in use possess serious defects. The so-called patent bottles which are closed by a porcelain stopper and a rubber ring are condemned by the bacteriologist because they cannot be cleaned and freed of bacteria so perfectly as to make them fit containers for a liquid so prone to decomposition as milk. The bottles covered with paper caps are objectionable because the caps and the mouths of the bottles are handled in transport and therefore necessarily become conveyors of germs. Furthermore it is not practicable to make or to apply the caps by absolutely aseptic processes.

The new "uviol" method of bottling milk uses a seal which satisfies every requirement of bacteriological science and allows a perfectly aseptic handling of the milk. This seal is a disk of tinfoil which is coated on its lower side with a germ free stiffening material and which comes to the bottling room in a germ free package. The bottles are sterilized before being filled and are sealed by an automatic machine neither the seal nor the mouth of the bottle coming into contact with a human hand during the operation.

Another obstacle to the increased use of milk in large cities is the uncertainty whether the milk comes from healthy or from diseased cows. The old remedy for this state of things consisted in boiling the milk and thereby seriously impairing both its flavor and its nutritive value. The necessity of boiling all milk in order to escape the danger of swallowing disease germs has caused a great many persons to abstain from milk altogether. Those persons who prefer bottled milk in its natural condition to boiled milk are certainly far more numerous than those to whom the taste of boiled milk is not disagreeable. It is equally certain that raw milk is more effective than boiled milk in promoting the growth and increasing the blood supply of infants whose food consists entirely of milk.

In the manufacture of butter and cheese also sterilization of the milk by some method other than boiling is not only desirable but sometimes absolutely necessary. Although many butter makers pasteurize the milk it is well known that the process injures the flavor and quality of the butter. The heating of milk used for cheese making although it is enjoined by the new (German) cattle plague law cannot always be employed because it seriously affects the formation of the curd.

In the feeding of calves and pigs also experience has proved that better results are obtained from raw than from boiled milk and the feeding value of such waste products as curds and whey would be greatly increased if they could be used in the raw state without danger of infection with tuberculosis or intestinal disease.

For these reasons the uviol process which destroys disease germs but spares the acidifying organisms in milk has been developed. The process is based upon the power of violet and ultra violet rays to paralyse the growth of vegetable organisms. The bactericidal efficiency of these rays is now universally recognized. By the uviol process the germs of disease chiefly tubercle bacilli and pus forming bacteria which the milk of a cow may contain even before the veterinary inspector can detect the disease and remove the animal from the herd are killed without altering the natural state of the raw milk.

In the industries dependent on fermentation also the uviol process will soon find important applications as yeast and mold fungi are likewise destroyed though less rapidly than bacteria by ultra violet rays.

The success which has been attained in purifying water with ozone has naturally led to attempts to sterilize milk by means of the same agent. The experiments soon proved however that the conditions in the two cases are entirely different. In water the destruction of organic matter is desirable but in milk this must be avoided if the milk is to remain fit for use as food. The quantities both of organic matter and of bacteria which the two liquids contain also differ widely. Even the results obtained in ozoning water however appear to indicate that milk cannot be perfectly sterilized by direct action of an electric current because the ozone generated by the current passes through the liquid in large bubbles making unfit for use those portions of the milk which it touches and exerting no germicidal action on the rest of the milk. In order to sterilize milk completely without injuring it the ozone must pass rapidly through it and come into contact with every particle.

For this purpose Dr Emil Wiener has made experiments with atomizers producing sprays of exceeding fineness in which the diameters of the drops range from 12 to 20 millionths of an inch. As these drops are little larger than bacteria any bacteria which they contain are fully exposed to the action of ozone coming into contact with the drops and are instantly killed even by greatly diluted ozone. The ozone is then quickly removed from the milk by the same apparatus by which it is applied. In this apparatus the milk is atomized by a jet of compressed air mixed with ozone. The milk falls to the bottom of a glass vessel from which the ozonized air escapes by an orifice above the level of the liquid. Before the milk is drawn off it is thoroughly aerated by a current of compressed air which has been filtered through glass wool calcium chloride and soda lime. In this way Dr Wiener succeeded in freeing milk completely from disease germs and toxins and improving its "keeping" qualities without affecting its taste odor or chemical composition.—Umschau.

Progress in Aviation in 1910

A Review of a Remarkable Year

By Rene Gasnier

At the end of each year it is interesting to review the progress accomplished and the tendencies developed in aviation

The most striking feature of aviation in 1910 is the number of remarkable exploits performed during its last few months Nothing seems impossible to aviators The offer of a prize of $20 000 immediately brings out new men who accomplish often with loss of life feats that yesterday seemed impossible Most of the numerous fatalities are due to the breaking of parts during flight Casualties caused by landing and by capsizing in squalls are comparatively infrequent Hence aeroplanes should be constructed with the factor of safety employed in other constructions and as the breaking of a part is generally irreparable all important parts should be duplicated Several aeroplanes with double running rigging and rudder controls have been exhibited The Maurice Farman is especially well made in this respect and all moving wires run on ball bearing pullies

The types which we had to review last year were the Voisin Farman Wright and Curtiss biplanes and the Antoinette one seated Blériot two seated Blériot and Santos Dumont monoplanes We will examine the changes made in these machines this year and briefly mention the newcomers

Last year the Voisin obtained lateral stability from vertical partitions which gave it the appearance of a cellular kite This unsatisfactory device has been replaced by ailerons resembling those of the Farman Lateral equilibrium can apparently be maintained equally well by employing ailerons or by warping the sustaining planes although warping is evidently a more powerful means especially in monoplanes where it is the only method in use In biplanes warping slightly weakens the transverse frame In very large biplanes ailerons would probably be used exclusively

Last year the Wright had an elevating rudder in front but none behind and was consequently very unstable Its stability has been very greatly improved by adding a horizontal rudder behind which works in combination with the forward rudder This result suggested to constructors the possibility of suppressing the forward rudder altogether This was done in the case of the Voisin biplane which subsequently made the remarkable flight from Paris to Bordeaux Wright and Farman have also obtained excellent results from the suppression of the forward rudder For the present however Farman together with Maurice Farman and Sommer retains the combined forward and after rudders

The possibility of flying with a single horizontal rudder placed at the stern shows that the true type is that of the French school the monoplane constructed on the model of a bird As I predicted last year this form has triumphed over the American type having a forward rudder which tends to destroy the equilibrium

This year two new biplanes have appeared the Bréguet and the Goupy which resembles monoplanes in the relative positions of the sustaining planes, motor rudder and pilot This is the true type of aeroplane whether monoplane or biplane The biplane construction allows the sustaining surface and consequently the load to be increased almost indefinitely The monoplane opposes less resistance to forward motion and can therefore attain greater speed with equal power It also maintains its equilibrium better in high winds owing to its greater velocity and its greater weight in proportion to surface and because its single plane is less affected by gusts and eddies than the superposed surfaces of the biplane

Whatever the type of aeroplane the aviator is far better protected from injury in the event of a bad landing if his seat is behind the motor than if he sits in front exposed to the first shock and liable to be hit in the back by the motor

The monoplanes have changed little during the year The Antoinette remains exactly as it was and the one-seated Blériot has undergone very slight modifications The Blériot with two seats beneath the wings has given place to a form in which pilot and passenger sit side by side in the position occupied by the pilot of the smaller machine The Santos-Dumont remains unchanged This machine is far safer than is generally believed and it would work well if a sufficiently light low power motor could be obtained

Among the new monoplanes the Hanriot, which resembles the Antoinette has performed very well in the contests in which it has taken part. The Tellier is a modified Blériot, with especially well-constructed rigging The Nieuport is a machine of peculiar type which opposes very small resistance to forward motion The Sommer closely resembles the Blériot. The Esnault-Pelterie looks like a great bird and in a beauty contest I would award the highest prizes to this machine and the Antoinette

It is almost impossible to give complete and exact descriptions of the different types because their motors and the area and curvature of the planes are not the same in all machines of the same type One Blériot for example has a 25 horse-power motor a greatly curved sustaining surface of 172 square feet and a speed of 37 miles per hour another has a 50 horse-power motor a slightly curved surface of 150 square feet and a speed of 65 miles a third has a 100 horse power motor a perfectly flat surface of 129 square feet and a speed of 81 miles The form of the curvature varies greatly in the different types Antoinette always employs the arc of a circle but the wings of most other machines have a maximum curvature near the front and some have an inverse curvature close to the edge Some machines have flexible wings These diverse forms have been adopted after testing a few surfaces with the dynamometer We are still far from perfection and we have no very precise data to guide us to it All constructors except Henry Farman employ thick wings The center of gravity has scarcely shifted In monoplanes it lies almost immediately under the wings and relatively higher than in biplanes where it is situated from 12 to 16 inches above the lower plane The stabilizing planes contribute to support in the one-seated Blériot and the machines of both Farmans Voisin and Sommer but not in the two-seated Blériot the Antoinette Esnault Pelterie or Hanriot Which of these systems is the better? We see that Blériot employs both

In some machines the pilot is placed in front of the motor in others behind it The distance between these two principal weights varies from nothing in the Wright where the pilot sits beside the motor to 13 feet or more in the Antoinette which is the most sluggish in evolution of all aeroplanes Blériot seems to have found the happy mean which allows the bow to be raised quickly enough to land easily and safely

All aviators are now agreed in preferring the start from wheels which Wright the only one who did not employ it has at last been forced to adopt With the great and swift machines of the future skids and rails may again become necessary In landing, some aviators use wheels some skids and some employ both skids and wheels Blériot and Voisin rely entirely on wheels but this is a bad plan because the machine runs a long distance on the ground and may be upset by a stone or a hole A better system is that employed by Farman Sommer and Hanriot in which skids pushed down to the ground after striking take the load from the wheels and quickly bring the machine to a stop There is also a tendency to use retractile starting wheels and to land on the skids alone In my opinion this is the best method It has been proved that if the pilot has an unobstructed view in front he can land very gently without employing springs even with the heaviest machine In monoplanes the shock of landing is often increased by the fact that the pilot cannot determine the instant of striking with precision A skid flanked by two wheels is often used in monoplanes This excellent plan has been adopted by Esnault-Pelterie and Nieuport.

Systems of rudder control show as much diversity as they did last year I prefer Blériot's well known system which is also employed by Tellier The same effect is produced by the single lever of Farman and Sommer Several pilots have passed from Farman to Blériot machines and have at once guided the latter perfectly The same movements are required in both machines—forward for rising, backward for descending to right or left for warping the planes or inclining the ailerons—and in both the steering rudder is operated by the feet. The Blériot system, however with its little wheel directly in front of the pilot and turned with either hand, appears more practical.

Great improvements have been made in the construction of aeroplanes during the past year Some makers turn out machines in stock sizes, with all of their parts carefully finished. The Blériot and Esnault-Pelterie machines are particularly well made. A few aeroplane makers are beginning to construct frames entirely of steel tubes. Voisin [illegible] a machine built of tubes which are joined [illegible] tubes, in addition to their other merits, keep their shape when exposed to dampness, which rapidly warps wooden frames On the other hand steel deteriorates when subjected to vibration, and airship builders have encountered serious difficulties in the construction of long gondolas of steel tubing Hence I should prefer to retain wood as the main constructive material although steel tubes might advantageously be substituted for some of the vertical supports The Antoinette machines are always flawless in construction I am glad to see that several constructors are substituting steel ropes like those used in ships, for the piano wire which breaks so frequently

The wooden propeller has finally won the field This year the metal propeller is employed by Voisin alone The wooden propeller is more efficient than the metal propeller because it is perfectly smooth and it is also far safer Reducing gear is seldom used although it presents certain advantages Bréguet has carried five persons with a propeller geared to make 600 revolutions per minute The direct drive is preferred however because of its lightness and simplicity The diameter of the propeller which last year was generally about 7 feet has been increased to 8½ or 9 feet. A large propeller geared down to 600 revolutions would be desirable for a machine of great surface carrying several passengers but for a small and swift monoplane the propeller attached directly to the motor shaft is preferable Twin propellers are used in few machines except the Wright and the Lioré They present little advantage and increase the chance of accident Chauvière exhibited at the Salon d Aviation an interesting device for testing propellers on an automobile

Many pages might be devoted to motors Last year we had few light weight types but there are many this year At the head of the list stands the admirable Gnome motor with which many of the remarkable recent feats of aviation have been accomplished Many persons at first did not believe in the rotary motor but they have been compelled to accept the facts This admirably simple device represents the true type of aeroplane motor and a step toward the ideal turbine motor Many motors with four and eight cylinders are highly esteemed but none of them rivals the Gnome in lightness Among the air cooled motors the Esnault Pelterie is remarkable on account of the severe tests which it has passed successfully Still more notable is the splendid performance of the Antoinette water-cooled motor which accomplished 1,800 miles in one week at the Bordeaux meeting. This would be a pretty good record for an automobile The aeroplane motor is evidently becoming sharply differentiated from its elder brother the automobile, and is assuming a form especially adapted to its own work Aviators are beginning to demand in addition to the greatest attainable lightness a small consumption of fuel and a range of speed which is indispensable for landing It is dangerous to descend rapidly with the motor working at full speed but if the ignition is cut off and the descent made by soaring it is impossible to start the motor again if a forward impulse is needed on approaching the ground If the motor would be kept going at a very slow speed which could be increased at the critical moment, the descent could be made with perfect safety

Two very original and interesting aeroplanes were exhibited at the Salon by Fabre and Coanda. The Fabre machine is the only aeroplane that has ever risen from and alighted on water Its trussed frame appears very strong, but it would be better to conceal the trusses inside thick wings The Coanda aeroplane has a fantastic appearance The resistance to progression is reduced to a minimum. The form of the wings, which are made of wood, was adopted after numerous tests made on rapid railway trains, but the wings appear weak, as they have neither vertical nor horizontal braces This machine is to be driven by a turbine which the inventor expects to develop astonishing power

Inventors have not made much progress this year The Salon had little to show except slight improvements on the types of last year The audacity of the pilots however, stimulated by the offer of large prizes, has revealed unsuspected qualities in the aeroplanes. Let us hope that the invention of new types will be similarly encouraged next year. The [illegible] of the Salon [illegible] Blériot, [illegible] Voisin, the Wrights [illegible] [illegible]

[illegible] general tendency toward uniformity of type is [illegible]. The monoplane and the biplane are progressing along the same lines, although their goals are different.

The time has come to build touring aeroplanes which will not break in the air The pilot and the passengers should be comfortably installed in cars securely mounted inside the frame where they will be protected as completely as possibly against the violent shock which is always liable to occur in landing on bad ground.

A good method of quickly stopping the aeroplane after landing is required There is still room for much improvement in the forms of wings and propellers and in diminishing the resistance to progression It is also necessary to organize soaring contests and to offer large prizes for the smallest angle of ascent At present what is called a soaring descent is a swift motorless dash down a grade of nearly 45 degrees

These are a few of the important problems that await solution With the motors now available this year's astonishing feats of aviation can easily be surpassed In 1911 we may expect to see the long-distance races which marked the early years of the automobile repeated with aeroplanes —Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from L Aerophile

The Limits of Our Chemical Knowledge

Some Modern Problems

By Dr William Eichholtz

THE last few years have enriched science and technology with discoveries and inventions of the most sensational character It is not surprising that a generation which has witnessed the discovery of Roentgen rays and radium and the development of wireless telegraphy airships and aeroplanes should become *blasé* and refuse to be greatly impressed by anything The brilliancy of the new discoveries casts into the shade the years of patient toil which preceded them and also the numberless problems that yet remain unsolved

We know to-day that there is no specific vital force which gives vitality to all living creatures We think we know that life is merely the sum of the biochemical processes which take place in the individual cells of the organism and that these processes are governed by the same laws that govern chemical reactions in the laboratory But the chemical processes of the body though similar to those which we have learned to control in the laboratory are exceedingly complex and we know very little of their details

Many persons are surprised when they are told that it is impossible in some cases to detect adulteration of food and can scarcely believe that science is still so impotent Most articles of food are natural products and consist mainly of the very complex organic substances When it is explained that we do not know the chemical structure of albumen the most important constituent of every animal and vegetable cell and that most of the substances which give foodstuffs their characteristic flavors and odors cannot even be chemically defined it may be understood why the chemist finds it very difficult and often impossible to distinguish pure from adulterated wine or genuine from artificial butter

The statement that we do not know the chemical structure of albumen does not mean that we are entirely ignorant of the composition of albumen We know that albumen contains certain chemical elements combined in certain proportions but this knowledge does not give a mental picture of the structure of the albumen molecule

Quantitative analysis suffices to explain the composition of most minerals and inorganic salts but the quantitative determination of the elements of an organic compound gives little knowledge of the chemical structure and character of that compound In view of the small number of elements—carbon oxygen hydrogen and nitrogen—which make up most of the countless and infinitely diverse organic compounds percentages mean nothing and arrangement or structure is everything In many instances two or more obviously different substances have precisely the same percentage composition For example formaldehyde the aqueous solution of which is well known under the name formalin is identical in percentage composition with grape sugar and some other carbohydrates

The chemical investigation of natural products is made more difficult by the almost invariable association of a number of similar and nearly related homologous compounds Butter for example contains a long series of fatty acids which shade into each other so gradually that the series can only be resolved into a number of groups which defy analysis into their individual members Fruit juices similarly contain series of organic acids

The systematic methods of inorganic analysis are therefore inapplicable to organic bodies and the reproach cast upon food analysis has very little justification for it is not and it never will be possible to determine the ingredients of animal and vegetable products by the rigid system and with the absolute certainty with which a skilled chemist can analyze the most complex of inorganic substances

In many cases the adulteration or falsification of food products can be detected only by means of some unimportant ingredient which happens to produce a striking reaction For example genuine honey contains microscopic grains of pollen If these are absent the genuineness of the honey may be doubted Unfortunately however the adulterators keep pace with the progress of science and mix artificial pollen grains with their artificial honey All margarine sold in Germany must according to law contain an admixture of oil of sesame which produces a brilliant color when the reagent furfurol is added Without this admixture of oil of sesame it would be very tedious and difficult to distinguish margarine from butter This can be done in some cases by determining the proportion of volatile fatty acids which are usually more abundant in butter than in margarine The quantity of these volatile acids in butter however varies with the season the stage of lactation and the breed of cows and it sometimes falls below the prescribed limit It is especially difficult to discover whether a specimen of butter is adulterated with margarine and if so to what extent and in many cases it would be quite impossible to detect such adulteration without the compulsory 'latent coloring of margarine with oil of sesame

The detection of adulteration and falsification in wine is still more difficult It is known that there are mixtures sold as wine which contain not a drop of grape juice and which yet defy detection by chemical analysis The chemist cannot even distinguish the coloring matter of red wine from that of huckleberries probably because the two are chemically identical

The consumer however cares nothing for chemical identity He wishes to know the source of his food but in this inquiry the chemist is restricted to limits fixed by nature In one instance these limits have recently been transcended but not by the chemist. The nice discrimination between varieties of albumen which chemistry is unable to make has been brilliantly accomplished by biological science

If an extract of horse flesh or the serum of horse blood is injected repeatedly during a considerable period into the circulation of a rabbit a substance called an antitoxin which precipitates the albumen of horses and that alone is formed in the blood of the rabbit Hence if the serum of the rabbit which has been thus treated is mixed with an extract made from suspected meat the presence of horse flesh in the meat will be indicated by the formation of a precipitate This method is already extensively employed for the detection of horse flesh in sausages An antitoxin which precipitates human albumen alone and which is useful for the detection of human blood in the investigation of crimes is prepared by a similar process

This biological reaction which is called Uhlenhuth's reaction from the name of its discoverer is distinguished from most chemical reactions by its delicacy and precision It can be applied with success to exceedingly small quantities of matter

Our chemical knowledge then is still very imperfect but it must not be forgotten that chemical problems are proposed by nature and are as numerous as the products and processes of nature Every natural product theoretically presents three problems its composition its utility and its artificial or synthetic production

Technical problems which are not of chemical nature are usually accompanied by their solutions on their first appearance

The necessity of traveling 60 miles an hour was not felt until long after the steam engine had been invented Such wants are rather suggested and slowly impressed upon conservative humanity by the existence of means of supplying them Hence technical inventions are thankfully received as unexpected gifts while chemical discoveries are regarded as long deferred payments of just dues There are exceptions however to both of these rules The problem of flight has occupied humanity for thousands of years and on the other hand synthetic chemistry has given us medicines dyestuffs and other substances which have become indispensable although they occur nowhere in nature but were created in the chemical laboratory —Ueber Land und Meer

How Birds Work Together

TURNSTONE is the name of a variety of shore-birds that are allied to the plovers and the sand pipers This name has been given to them because of their singular manner of feeding With their strong bills they turn over the small stones lying in the sand of the beaches to find the insects that may be sheltered underneath. If the stone prove too heavy for the bill, they push it over by applying the breast to the upper side Frequently a number of these birds will work together to turn over an object that is too heavy for one alone to move

Two little workers were once seen busily endeavoring to turn over a dead fish that was fully six times their size. They were boldly pushing at the fish with their bills and then with their breasts. Their endeavors were, however, in vain and the object remained immovable.

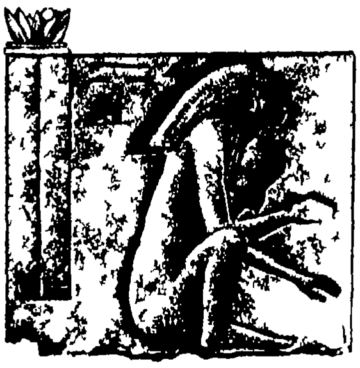
Then they both went round to the opposite side and began to scrape away the sand from beneath the fish. [illegible] removing a considerable quantity, they again [illegible] to the spot where they had been, and went [illegible] work with their bills and breasts, but [illegible] as before. Nothing [illegible] a second time to the other side and recommenced their trenching operations with a seeming determination not to be baffled in their object which evidently was to undermine the dead creature before them in order that it might be the more easily overturned

While they were thus employed and after they had labored in this manner at both sides alternately for nearly half an hour they were joined by another of their species which came flying with rapidity from the neighboring rocks Its timely arrival was hailed with evident signs of joy

Their mutual congratulations being over they all three set to work and after laboring vigorously for a few minutes in removing the sand they came round to the other side and putting their breasts to the fish succeeded in raising it some inches from the sand but were unable to turn it over It went down again into its sandy bed to their manifest disappointment.

Resting however for a space, and without leaving their respective positions which were a little apart the one from the other, they resolved it appeared, to give the work another trial. Lowering themselves, with their breasts close to the sand, they managed to push their bills underneath the fish, which they made to rise about the same height as before Afterward withdrawing their bills but without losing the advantage which they had gained they applied their breasts to the object This they did with such force and to such purpose that at last it went over and rolled several yards down a slight declivity It was followed to some distance by the birds themselves before they could recover their bearing

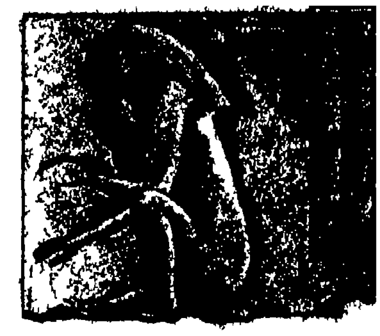
To Color Tin Solder Yellow —Prepare first a saturated solution of blue vitriol in water dip a polishing stick into it with which the place to be soldered is moistened Touch the spot thus moistened with an iron or steel wire or rod If this is frequently repeated copper will be deposited To produce yellow color the spot is moistened with a mixture of 1 part of saturated aqueous solution of white vitriol and 2 parts of blue vitriol solution by means of a zinc rod The spot is to be finally rubbed with gilding powder and polished with the burnisher In the case of gilded objects the coppered spot should be coated with a thin covering of gum or isinglass solution dusted with bronze powder and after drying brushed smooth For silver articles the coppered place is to be rubbed with silvering powder, brushed and polished.



The Temple of Hibis*

Results of the Metropolitan Museum's Expedition

By H E Winlock



During the past winter the Egyptian Expedition of the Museum has conducted the excavations at the Temple of Hibis in Kharga Oasis The temple is one built chiefly in the reign of Darius the Great about the beginning of the fifth century before Christ and its clearing was undertaken by the expedition because of its importance as the only architectural monument of the period between the decay of the Theban Kingdom and the conquest of Alexander the Great which exists today in good preservation

Prof Gaston Maspero Directeur Général du Service des Antiquités d'Egypte assigned M Emile Baraize an engineer of the service to the task of consolidating and restoring the temple at the expense of the Egyptian government while it was being cleared by the expedition The latter owes its acknowledgments to Prof Maspero for making it possible to conduct the two pieces of work—the clearing and the restoration of the temple—in co-operation and especially to M Baraize for his unfailing helpfulness not only in the special task he was undertaking on behalf of the service but also in all of the other work connected with the excavations The collating of previously published copies of the temple hieroglyphic inscriptions with the originals and the copying of inscriptions and scenes which have not been published heretofore or which have been brought to light during the past winter were started by N de G Davies of the expedition In connection with and supplementing the Davies copies Friedrich Koch has begun a series of photographs which it is hoped to finish during the coming season and which it is intended shall be a complete record of all the reliefs and inscriptions in the temple The Greek decrees mentioned in the expedition's last report as well as some new decrees shorter inscriptions and graffiti found this year have been copied and are being prepared for publication by H G Evelyn White while the plans and architectural gave up some of the land about the eastern gateways These questions took up a great deal of time throughout the winter and their ultimate solution was almost entirely due to M Baraize but meanwhile about the middle of December a preliminary agreement had been arrived at a light railway was installed similar to that which had been in use at Lisht, and excavations were begun at the portal of Darius and pushed westward From the very beginning of the excavations fallen blocks from the temple were found buried to greater or less depths in the soil and drift-sand First to be cleared was the portico of Nectanebo Part of the screen walls of the north and south sides had always remained visible above the surface but in the course of the excavations practically all of the columns and cornice which had risen above these two sides were brought to light lying just as they had fallen each stone in relation to the next in such a way that a reconstruction of the elevation could be definitely made As the work proceeded through the great eastern doorway of the temple the fallen blocks were found in greater and greater numbers until when inside the large hypostyle hall the removal of the sand brought to light a mass of stones in great confusion filling the hall to a depth of several meters above the pavement (Figs and 2) These were the drums and capitals of six fallen columns and the architraves and roofing slabs which had been supported by them Most of the columns could be completely recovered but the majority of the pieces from the roof were so broken that to restore them to their original positions was found to be impossible In order to continue the clearing all of them had to be removed but as the greater part were extremely massive the process was slow and difficult (Fig 1)

At this time the force of workmen numbered nearly two hundred and as it was impossible to employ so many in the hypostyle the majority were transferred trenches were sunk below the surface to bed rock On the west the work had to be stopped within ten meters of the temple wall; but on the south, where the cultivation did not approach the temple so closely a much larger area, covering about three thousand square meters was cleared (Fig. 3) The work at this point was extended early in February to a low mound rising on the edge of the cultivation where traces of buildings had been found on the surface. The greater part of the rest of the season was spent in exploring the network of mud brick walls uncovered here At the end of the work some modern structures were removed from among the eastern gateways but no other attempt to excavate in the palm grove has yet been made The work in the field was brought to a close the first of May

The consolidation and restoration of the temple by M Baraize was begun about the middle of January and continued to the end of the season A great deal of this time was spent in replacing with new masonry the stones in the lower courses which had been eaten away by the moisture and salts in the soil in which they had been buried In order to make the walls capable of sustaining their own weight after they were exposed In the case of one partly fallen column in the hypostyle hall this operation necessitated the taking down of the standing courses and the complete renewal of the foundations In addition a great deal of the fallen structure recovered in the clearing was restored to its original positions In the hypostyle two of the six fallen columns were set up again and some parts of the screen wall and columns of the offering hall a great many blocks of the fallen cornice from the exterior and some of the frieze at the top of the walls inside the temple were replaced and the greater part of the west wall of the temple was rebuilt from the bottom courses to its original height such of the blocks as

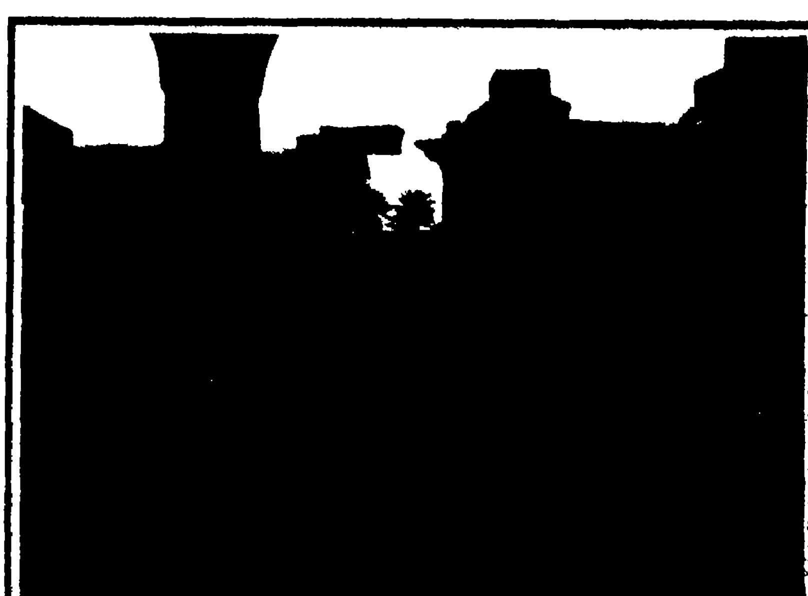


FIG 2 – HYPOSTYLE HALL LOOKING EAST AFTER THE REMOVAL OF THE SAND SHOWING FALLEN ROOF AND COLUMNS

FIG 1 – HYPOSTYLE HALL, TEMPLE OF HIBIS, KHARGA LOOKING WEST, DURING THE COURSE OF THE REMOVAL OF THE FALLEN BLOCKS

THE EGYPTIAN EXPEDITION

drawings are being done by William J Jones both of whom are members of the expedition

The field work in the oasis began the first of December As the temple is situated in the midst of the peasants farms the first step was to open negotiations with the land owners of the neighborhood with a view to procuring a place where the earth and sand from the excavations could be dumped and obtaining the title to some of the land in private possession adjoining the ruins which it was desirable to dig Eventually an arrangement was made by which the expedition was able to dump into a low salt marsh at the foot of the temple hill and in exchange for this filling and improvements of their lands, the owners to the excavation of the exterior Eventually as the entire task of transporting the blocks in the hypostyle was undertaken by M Baraize all of the expedition's workmen were engaged in running spurs of the light railway around the north and south sides of the temple and in clearing away the larger drifts of sand and débris collected there. In this way two side-openings were found into the offering hall, by which the chambers in the back of the temple could be entered and cleared while the hypostyle was still blocked The excavations on both sides of the temple were carried on by means of the railway down to the ancient surface level. To the north, an area of over one thousand square meters was dug in this way to a depth of two or three meters, and [illegible] were missing being replaced with new masonry. This restoration is to be continued next year in conjunction with the further excavation.

The clearing and rebuilding of the Temple of Hibis has disclosed new features in the plan and decoration, including some interesting reliefs which have been brought to light on walls heretofore buried. One shows the king, Darius, in a boat, picking [illegible] flowers to offer to the god Min, and another, the god Sutekh the popular deity of the oasis, [illegible] the Serpent of Evil (Fig. 4) In the ruins of the portico of Nectanebo there was found, [illegible] columns from the north and the [illegible] to be restored, as [illegible]

* Bulletin of the Metropolitan Museum of Art

its coloring almost intact. It is probably the capital of one of the four columns of the almost completely destroyed eastern façade, but although its position has been ascertained with a good deal of certainty not enough of the column and substructure remains to replace it. It has therefore been brought to the Metropolitan Museum of Art.

Additional knowledge of the history of the temple has been gained also by the excavations. A fragment was found of an offering bowl of dark blue schist way like those at Kom Ombo and Edfu has been discovered and dated to the reign of Ptolemy II Philadelphos (B. C. 285-247) from a fragment of the dedication inscription in Greek. Among the fallen blocks of this wall there have been found a great many pieces of relief of the reigns of Ptolemy III Euergetes (B. C. 247-222) and of a later Ptolemy and his consort Cleopatra, but it is impossible to tell yet whether they come from decoration of the wall itself or from some other structures which may have existed near by. Indeed the whole site seems to have flourished throughout the Ptolemaic period, as besides these structures and the inclosure wall and pylons on the east already known, there were discovered on the south the foundations of a large Ptolemaic brick structure with a stone portico and near by were found coins, pottery and small bronze ex-votos which had been originally in the temple. This prosperity continued at least to the first centuries of the Roman period, when a certain Herakleides dedicated a new pavement and one Heraklios built piers in the hypostyle to support the then endangered roof.

But from the third or fourth century after Christ evident signs of decay are noticeable. The inclosure walls were broken in places and private houses encroached on the temple area. From these the excavations recovered coins, ostraka, a bronze lamp and a good deal of pottery. At the abandonment of the temple as a place of pagan worship the dwellings were built against the outside walls and among the columns of the hypostyle halls and in the northeast corner there was erected a small Christian church. Fragments of glaze found in connection with this last occupation show that it continued until after the Arab conquest, archæological evidence which it is possible to verify inscriptionally by several Coptic graffiti in the tombs of the Necropolis el Haguat and on the rocks of Gebel-et Têr. Among these latter is a prayer signed and dated in the eighth century after Christ by Severus son of the Pagarch of Hibis.

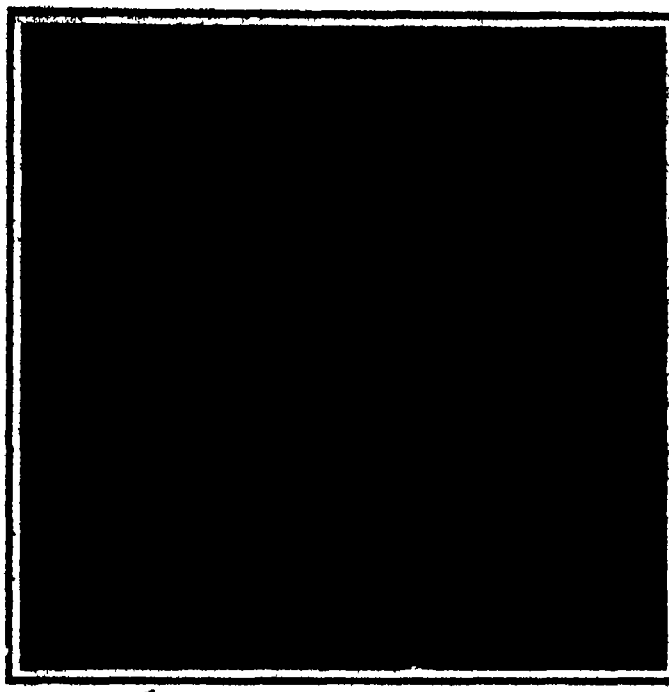


FIG. 14.—RELIEF FROM NORTHWEST CORNER OF HYPOSTYLE HALL SUTEKH SLAYING THE SERPENT OF EVIL REIGN OF DARIUS

FIG. 8. GENERAL VIEW OF THE EXCAVATIONS SOUTH OF THE TEMPLE IN THE FOREGROUND PART OF THE FOUNDATIONS OF PTOLEMAIC BUILDING

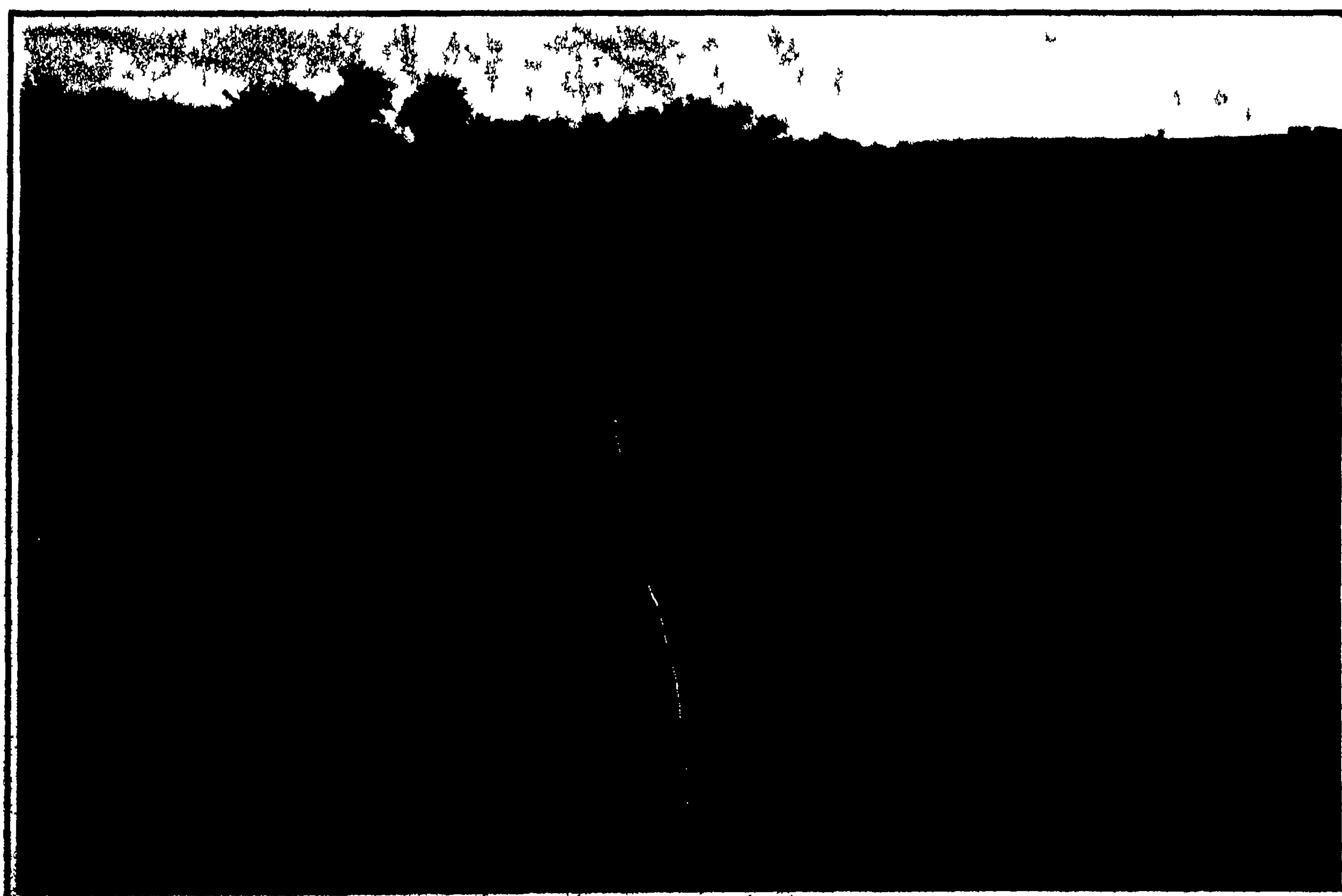


FIG. 5.—HYPOSTYLE HALL VIEWED FROM THE TOP OF THE TEMPLE AFTER THE REMOVAL OF THE SAND SHOWING FALLEN ROOF AND COLUMNS

THE EGYPTIAN EXPEDITION

dedicated in the reign of Apries (B. C. 588-569) which has been apparently a piece of temple furniture and which therefore points to the existence of a temple on this site at least as early as the Saite period. Of the existing temple five stages of construction have [illegible] earlier than the reign of Nectanebo, [illegible] additions and changes were [illegible] have been [illegible] hitherto. As [illegible] of the temple [illegible]

What is the Ether?*

The History and Necessity of a Remarkable Conception

By Owen Ely

SINCE the time of Newton physicists have seen the n ed of assuming an ether to explain action at a distance or the passage of electric and magnetic forces through empty spa e Though these phenomena have been th r ugh y st died through experimental research comparat ve y little work has been done to deduce from the laws and facts at our disposal the real properties and onditions of the ether The concepts of a ether have generally been so mystical and vague that scientists have sh nned the task of correlating or confirming the n Bu more recently science has realized the importance of this realm of inquiry Lorentz Larmor Thomson Kelvin Lodge and others have sought some basis f experimentation and have attempted to b ild com lete and consistent theories Results are slowly a umulating more definite hypotheses are being formulated and perhaps a few more decades will give us a fairly complete knowledge of this understratum of nature

The first important theory of he ether was developed by Green and others in the early part of the nineteenth century The ether was regarded as a kind of incompressible jelly easily set a-quiver by the motions of the molecules and able to transmit this motion through its vast bulk to the ends of space And yet for any motions of matter other than the molecular the ether was thought to act as a perfect fluid This provision was ne essary to limit the ether to transverse vibrations Owing to the increasing demands which new dis overies in optics made upon the theory it was abandoned

One of the st pr ment theories which have been brought forward was that connected with Maxwell s electro magn ti theory of light The ether was ass med to be a bu ent fluid the particles of whi h osci late re olve or in some way change their on litio causi g the rapidly alternating polarizations whi h Maxw ll used to explain his conception of the ele tro-n ag etic wave Sir William Thomson in the Philosophi al Magazine for J ne 1853 gave the theoretical demonstration to prove that the reversing of an electric charge produces a polarization the same in kind as that which constitutes a light wave Later Hertz actually proved the identity But polarization is still little more than a name and there is yet some discussion as to whether it involves any bodily displacement of the ether

The ether having been regarded as a solid and a fluid it remained to treat it as a gas This was attempted by several among them Mendeleef the chemist But the results did not seem very satisfactory Evidently the ether needed properties of each state of matter solid fluid and gaseous Rigidity and elasticity of some sort were required that light should travel in a straight path the freedom of movement of a perfect fluid was necessary since apparently there was no friction between matter and ether and finally its inertness its fail re to affect matter of itself pointed to a la k of ohesion or activity among its partl les For those reasons apparently modern physicists have generally ceased trying to picture ether in terms of matter but rather are inclined to explain matter in terms of ether Thus Prof Osborne Reynolds who has worked upon his theory for many years regards the ether as a system of finely packed grains of which it would take same 112 10 to make 1 an inch and whose mean free path is 4 10 of their 1 amet r These round hard grains are piled up like billiard balls thro gh the universe but here and there is a cra k or separation and this vacuum is matter! The encounters of the cracks make up the phenomena of the cosmos

Larmor s concept seen s somewhat similar for he regards electrons as nuclei of permanent etherial strains in rapid motion Kelvin and his school lay emphasis upon an explanation of the ether s perfect elasticity Kelvin s famous theory of the ether makes its elasticity due to rotational motion—intimate fine-grained motion througho it the whole etherial region motion not of the nat re of locomotion but circula ion in closed c rves ret rning upon itself—vortex motion of a kind far more finely grained than any waves of light or any atomic or even electronic structure If the elasticity of any medium is to be ex plain d kinetically it follows as a necessary conseque e that the speed of this internal motion must be omparable to the speed of wave propagation that is say that the internal squirming circulation to which every part of the ether is subject, must be carr o with a velocity of the same order of magnitu le the velocity of light †

* Popular Astronomy

† Lodge, The Ether of Space (1909), pp 109-[illegible]

On this assumption Sir Oliver Lodge calculates that the ether must possess 3 10[14] kilowatt centuries per cubic millimeter or the energy of a million horse-power station working continuously for forty million years Kelvin s theory is based upon the principle of the gyroscope as applied to fluids which thus imitate solids Many experiments have been made to demonstrate the strange properties of liquids or flexible solids when in rapid motion. A silk cord moving swiftly over a pulley has become rigid and viscous and waves set up on the cord traveled with its velocity thus standing still This shows why "the speed of (the ether s) internal motion must be comparable to the speed of wave propagation" To show the elasticity of spinning bodies Lord Kelvin made a spring balance out of gyrostats* The hardness" of fluids in motion is illustrated by a stream of water under strong pressure which will resist blows from a sword.

Kelvin s gyroscopic theory however is useful only in providing a fluid ether with the elasticity of a solid And does it not seem futile to evolve an ether from the properties of matter when those properties in turn depend upon the ether? The action of the gyroscope involves the inertia of matter yet Prof J J Thomson and others are now inclined to explain inertia as an effect of the electromagnetic energy which a body carries about with it in the ether But if inertia is not an inherent" property of matter but rather a phenomenon involving ether why should it be used to endow the ether-particles? A second ether would be necessary to account for the inertia of the first Indeed it is so difficult to build up any hypothesis without the use of inertia and the laws of motion that we may be compelled at last to resort to another ether But since that is merely shifting the ultimate problem we must do our best to gain a simpler theory

Again it is difficult to conceive how the particles however fine grained their gyroscopic motion would avoid being in continual contact and collision destroying the permanency of the system and producing a gaseous state Motion in exact circles would be broken up and the gyroscopic principle no longer at work At least it is difficult to explain how any kind of motion can be provided for the crowded particles of ether other than some irregular chaotic vibration like that of a gaseous molecule The particle cannot be compared to the vibrating molecule in cohesive solids nor to the revolving electron for both must be held in their systematic orbits by forces acting through a medium The difficulty of making the ether circulate about a fixed center in order to make it gyroscopic and elastic seems about as large as the original problem itself

There are perhaps other ways of explaining the properties of rigidity and fluidity in the ether If matter be regarded as merely a crack or strain in the ether the latter need not be fluid since there could be no such thing as friction between matter and ether Then if the ether be thought of as quite densely packed with particles in orderly rows, columns and tiers it might not be difficult to imagine how a single pulse of light emanating from a molecule should continue like a missile having inertia to follow the straight line upon which it was started. For light is made up of waves in several planes which we may regard separately Motion in one plane cannot pass into another and if the tier of particles in which the wave started is not disturbed by passing matter the wave would remain in one plane But what prevents the wave from spreading about its plane instead of holding a straight path? This too must be a result of the regular arrangement of the particles, so that the wave moves as a uniform interaction among the particles of several rows confined to these rows alone, like a moving pendulum. Thus the simple pulse from a molecule in the Sun would reach our Earth practically unchanged The size of an object then, alters not because all the mingled pulses reach the eye diminished in size but because the number o pulses entering the eye undiminished depends upon the square of the distance Were the former the case and if the light-wave spread out like a sound wave as it emanated from a source some change in the structure of wave would take place and it would be difficult to explain the rectilinear propagation of light. The structure of the ether could scarcely be as perfect as pictured but if the particles be of a very small order of size compared to the light-wave the result should be about the same Only by this [illegible] indeed could we imagine the tubes, or parallel rows traversed by each wave, as stretching away from the source [illegible]

* Address to Section A of British Association [illegible]

every direction This description, crude as it is, may serve to show that the theory of the ether has not yet been exhaustively worked while it points out some of the difficulties in an adequate explanation of the actual transverse wave in ether

Having reviewed some of the general theories of the ether it will be interesting to look into the methods which have been used to gain facts and figures in regard to the ether and to see what tangible results have been reached.

A modern school of physicists have derived a value for the elasticity of the ether from the formula $V = \sqrt{\frac{K}{D}}$ or $K = V^2D$ The density of the ether has been calculated on the assumption that the electron is a differential portion of ether but of equal density The linear dimension of the electron is about 10[-13] or 10[-14] millimeters, and if its mass is not an effect of its magnetic field the various estimates based upon different experiments all yield the same result, about 10[12] c.g.s. units V^2 we know to be 9 10[20] so that $K =$ 10[33], the figure generally agreed upon by some of the greatest scientists The estimate is of little value however except as it may direct further inquiry The structure of the electron must be investigated before its density can safely be used to indicate that of the ether

Deductions have been made as to the structure of the ether from the computed velocities of the various wave-lengths of light in space But they are of questionable value for at present it is still a moot question whether or not the various waves have exactly the same velocity However it is an important line of research and will certainly yield us some knowledge of the ether We are too accustomed to treat light as a whole not as to particular wave-lengths Lord Rayleigh has said We have no means of identifying a particular wave so as to determine its rate of progress What we really do in most cases is to impress some peculiarity it may be of intensity or of polarization upon a part of an otherwise continuous train of waves and determine the velocity at which the peculiarity travels Rayleigh used the formula

$$U = \frac{d(kV)}{dk}$$

to express the possibility that V the velocity of a particular wave-length may differ from U the group velocity Now the work of Nordmann on Algol has tended to show that red rays (about 0 68μ) were sixteen minutes ahead of the blue (about 0 43μ) Pritchard s estimate of Algol s parallax is 0 0556 second or about 61 light-years Dr C V Burton using these data and Rayleigh s formula (L. E D Philosophical Magazine December 1909) has set up equations representing the conditions of periodic motion in the ether, in order to show that the velocity of propagation is a function of the wave-length and that no absorption need occur in the ether The laws of dispersion are applied to strings and by combination of these to three-dimensional space. The nature of the formulæ developed by him leads to the conclusion that "The system (of ether-particles) has a structure on a scale not infinitely minute compared with the wave-length Though we may conceive the electro-magnetic vibration of the ether to be executed in a manner widely different from anything occurring in these simple mechanical models we may yet attempt to form some idea of the coarseness of structure of the ether which could suffice to account for such dispersions as Nordmann and Tikhoff have thought to be indicated by their observations. The formula deduced by Dr Burton from Rayleigh's equation is $U = V_0$ $(1 - \pi^2b^2)$ [illegible] When this is applied to the figures given by Nordmann and Tikhoff above, the result is only 1 7 10[-4] centimeters and 3 1.01[-4] centimeters, respectively for b "a linear magnitude which expresses the coarseness of structure of the ether." But the electron is said to be only 10[-13] centimeters in diameter; and since the ether-particle should be of a lower order of size than the electron, this indicates that the observations are unreliable or the formula wrong. The fact that the two observations disagree in the ratio of nearly one to thirty has furnished an argument against the reality of dispersion. But if dispersion is proved to exist it must be attributed to the structure of the ether, since Lebedew has shown that it cannot be accounted for by the presence of any known substance in space (for example, hydrogen at low pressure) which would absorb [illegible] [illegible]

meter for full sunlight; and a quarter of a century later Lebedew, Nicaeis, and Hull verified the theory, the two latter reaching a figure within one per cent of Maxwell's estimate. Lately Prof. Poynting has measured the backward thrust of the light-wave as it leaves its source When we have worked out a definite picture of the electro-magnetic wave this primary fact should be very useful in explaining its genesis and the relation of the electron to the ether surrounding it.

It has been assumed, during the above discussion that no friction exists between matter and ether but the question was by no means settled until recent years Many experiments were tried during the past half century, but none were conclusive until Michelson made his famous experiment in 1887 This seemed at first to show that the ether is stagnant about the Earth or that it does not rush by us and through us at the rate of the Earth's motion Two half beams of light, one sent to and fro along the line of the ether drift, east and west and the other across the line of drift, were reunited and should have shown a displacement in the bands of the spectrum of one part in a hundred million—the square of the ratio of the speed of the Earth to that of light A change of one part in 4 000 millions could have been detected in the apparatus but no change was seen The explanation was first suggested by Prof G F Fitzgerald of Trinity College, Dublin, and was later developed by Prof H A. Lorentz of Leiden. The cohesion of the materials in the apparatus by which the measurements were made was probably due to electric charges in the atoms. The cohesion was then less great across the line of the Earth's motion than along it for the reason that the charges become currents on account of the Earth's motion, and the attraction between the parallel currents is less than in the currents which follow each other in the same line of motion Therefore although the light wave probably increased in velocity across the line of the Earth's motion the stone slab across which it traveled increased in length proportionately

An interesting and original experiment was undertaken by Sir Oliver Lodge to settle the question in a different way Two large steel disks an inch apart were rotated at enormous speed while a beam of light was divided by a semi transparent mirror and the two halves were sent in opposite directions around and between the disks until they met in a telescope After eliminating the sources of error it was found that the images were exactly coincident and that hence no ether had been caught up in the motion of the steel disks

Perhaps nothing has contributed so much to the possible development of a theory of the ether as the electron theory which has done so much to reduce phenomena to the inter play of the electro-static magnetic and inductive forces of charged atoms These forces together with matter which may be simply their source in the ether and gravitation which is probably an electro static effect constitute the whole problem of the ether The ultimate task is to explain them as the varieties of motion in the fundamental stuff

To sum up it is apparent that the problem of the ether the greatest enigma of all time cannot be solved by one group or generation or class of scientists It claims the work of specialists in many fields While each may see the task from his viewpoint alone it is worthy of attack from many standpoints To analyze and classify a nearly infinite variety of phenomena to reach the root causes of nature requires the genius of the investigator To arrange the data in the most logical relationships requires the work of the theorists To condense and reduce these relations to the simplest and most elegant form the brain of the mathematician is necessary To appreciate the ultimate significance of those factors which the others use but as the material of their building the philosopher is final critic And to make the results of all the others of interest and value to the human race as a whole the interpreter must picture them in simplest phrase and most apt illustration

Do Fishes Hear?

A Summary of Recent Studies

By Dr Wilhelm Roth

Although Saint Anthony of Padua preached to the fishes this is no proof that the fishes heard him for the holy man preached to many deaf ears An other ecclesiastical tradition which has often been cited in evidence of the auditory power of fishes has likewise failed to stand the test of critical investigation

The famous old Benedictine cloister of Krems in Austria, possesses a monumental fish pond surrounded by stone balustrades and arcades whose finny denizens have from time immemorial been summoned to their meals by acoustic signals—in the old days by beating a drum and in modern times by ringing a hand bell

Dr Alois Kreidl who had previously expressed the opinion that if the fishes really come in response to the ringing of a bell tney do so because they feel the vibration not because they hear it recently visited the monastery in company with Prof Exner the well known Viennese physiologist The investigators easily proved that the fishes did not hear the sound of the bell but came to the feeding place only when they saw the attendant ring the bell and throw out the food or when they felt the vibration communicated to the water by the man's footsteps on the stone run of the pond When the two observers approached the feeding place in such a manner that the fishes could not see them hid behind a column and there rang the bell the fishes did not take the slightest notice of the sound but when they came to the feeding place in the customary manner of the attendant without ringing the bell the fishes quickly swam to the spot. They dispersed immediately on finding that no food was forthcoming and could not be recalled by ringing the bell.

A similar explanation can be given of many other instances in which fishes are apparently attracted by the sound of the human voice of bells attached to fishing nets of drums and of the clappers which the Japanese employ in conjunction with torches in fishing with cormorants Kreidl and Exner found it impossible to elicit from goldfish any response to whistling the peal of a large bell and various other sounds generated in the air or even to tones produced by drawing a violin bow over metals bars under water Another experimenter obtained the same negative result with the ear splitting noise of the toy known as a cricket

Even when the reflex irritability of the fishes was greatly increased by dosing them with strychnine they responded only to sudden and violent sounds like that of a pistol shot which caused them to flee in terror As Langes and Vulpian have found that a pigeon which has been deprived of its brain and therefore of its sense of hearing responds to a pistol shot it appears probable that violent explosive noises affect the nerves of touch or feeling by means of the concussion of the air which is transmitted to fishes through the water

In order to prove decisively whether the reaction in the case of fishes is accomplished by any true auditory sensation or is caused entirely by mechanical stimulation of the tactile nerves Kreidl experimented with fishes from which the labyrinths of both ears had been removed These fishes reacted to very loud sounds in precisely the same manner as unaltered fishes when both had been dosed with strychnine

Hence there can be little doubt that in fishes the surface of the body has assumed the auditory function and that a perception of vibrations by the tactile nerves takes the place of a true sense of hearing It is natural to assume that in fishes the organs of the so-called lateral line which are sensitive to the slightest change in pressure correspond to the cochlea of higher vertebrates with its Corti's fibers which parts are entirely absent from the ears of fishes

We are not justified however in assuming that the ears of fishes play no part in the perception of vibrations produced by sound waves for the otoliths of the labyrinth may serve in fishes as they do in many other aquatic animals for the perception of vibration and may thus assist the organs of the lateral line of the body It is probable indeed that the labyrinth of the ear is only a highly developed and specialized lateral organ and according to Bonnier the perception of mechanical vibration is simply the initial stage of the sense of hearing The difference between the two functions is that in the former the vibrations of pressure are perceived separately while in the latter they are fused into a single tone as the mosaic image formed on the retina is seen as a single picture

Although the fishes that have been studied appear to possess no true sense of hearing it is not impossible that the ears of some fishes have acquired some slight development There are many fishes about 80 species which produce sounds In the pairing season some fishes fill the water with noise which can be heard plainly by an ear pressed to the ship's side Whether these sounds are produced voluntarily (perhaps to attract the opposite sex) or not is wholly unknown but even if some of these musical fishes are found to be sensitive to sounds of moderate intensity it will still remain probable that they perceive these sounds by a sense of vibration akin to the sense of touch and do not really hear them —Translated for the Scientific American Supplement from Umschau

The Transformation of Sea Water Into Fresh Water

The belief was prevalent among the savants of the 17th and 18th centuries that a hermetically sealed earthen vessel dipped into the sea would fill itself with fresh water At the present day it is difficult to say on what this belief was grounded It surely could not have been evoked by experiment. In a similar sense Marsigli, the founder of oceanology made in the year 1706 an experiment which effected the filtration of sea-water through a system of fifteen pots filled with washed garden-earth or sand and so placed as to let the water fall as if in a cascade It is stated that the palate disclosed a definite diminution of the presence of salt. Similar assertions are everywhere current among seamen.

A scientific test of the endeavor to free salt from water was recently made by the French investigator [illegible]. His report which appears in the minutes of the Académie des Sciences of Paris states that the [illegible] of salt can be reduced by filtration. Forty [illegible] of the length of a glass tube, which was [illegible] long and was placed in a perpendicular position [illegible] with [illegible] the rest of the tube [illegible] of the alkalis were [illegible] to ascertain the density and chemical composition The result was that in the initial stage of the experiment density as well as saline content were found to be moderately reduced very soon thereafter both recovered their original value The early decrease of value is explained by the mechanical attraction which every chemically neutral body exercises on the molecules of a substance in solution as soon as the body comes in contact with the solution In nature too sand fails to effect the separation of salt. Through shipwrecked seamen it became known that relatively fresh water may be found on very low and barren coral reefs in the Pacific Ocean by digging to a trifling depth in the coral sand It is not however as was supposed sea-water freed from salt through the layers of sand but is simply rain water that is retained by a sandy stratum and by it protected from admixture with the sea water Similar phenomena may be observed on the European coasts They may be considered the key to the popular belief now contradicted, that sea water can be sweetened by filtration through sand

Mr W Rosenhain, a well-known English metallurgist, in a report of the Advisory Committee for Aeronautics, reviews the results of researches on the alloys of aluminium containing small quantities of other metals so as to leave the density of the alloy very nearly as low as that of the pure metal and yet obtain the increased strength and hardness given to the alloy by such additions A certain number of these alloys are already in industrial use namely those containing Cu Ni Zn and Mg The mechanical tests of the Cu Al alloys containing 2 77 and 3 76 per cent of Cu are given and also the tests of two Cu Mn Al alloys containing respectively 2 per cent of Cu and 2 per cent of Mn and 3 per cent of Cu with 1 per cent Mn The elastic moduli of these latter alloys have been determined and are compared with wood The elastic modulus of wood is of the order of one-sixth of these alloys Some tests are given of Al Ni alloys which appear very promising but these are said by Guillet to easily corrode Some details are also given of the Al Zn alloys One of the most interesting of the Al alloys is known as wolframium or wolframinium which contains small quantities of Cu Sn Sb and W The alloys known as magnalium contain from 3 to 10 per cent Mg and it is claimed that they are 2 to 3½ times as strong as pure Al It is pointed out that there is a large field for possible improvement in the range of light alloys to be obtained by the addition of small proportions of heavier elements to Al.

Mixing Concrete on the Farm

How to Select Your Materials and Mix Your Own Concrete

On account of its cheapness uniformity and quick development of strength the only cement practically used at present is the kind called Portland There are almost as many brands of Portland cement as there are of wheat flour For farm work choose some brand guaranteed by the local dealer to meet the standard specifications of the American Society for Testing Materials which standards are approved by the national government

Cement takes water so easily that care must be exercised in storing it Upon the regular floor of a good building place timbers close together as a support for a false floor upon which the cement should be piled

Cement is heavy do not overload the floor of the building by piling it too high and do not store it against the side walls Keep it covered with canvas or roofing paper Cement once wet sets up and is unfit for use However lumps due to pressure in the storehouse must not be mistaken for set up cement Such lumps are easily crumbled and may then be used

Concrete is a mixture of Portland cement and particles of stone The stone should vary in size from pieces one inch in diameter to sand grains By so grading the stone the smaller particles fit in the spaces between the larger pieces thereby producing the most compact and the strongest mixture

The best stone for crushed rock is one which is clean hard and breaks with sharp angles Trap granite and hard limestone are among the best the use of shale slate and soft limestones and sandstones should be avoided The crushed rock should be screened on a ¼ inch screen to remove the fine particles These small particles should be considered as sand and if insufficient in quantity to make the proper proportion of the concrete as is described later enough sand should be added to them to produce the required amount

Gravel well graded in sizes is at least equally as good for concrete as crushed stone Bank run gravel just as dug from the pit seldom runs even and rarely has the right proportion of sand and pebbles for making the best concrete The mixture most suitable has one part sand to two parts gravel measured by volume in which all sizes passing through a 1 inch-mesh screen and retained on a ¼-inch screen are considered gravel As there is usually too much sand for the gravel it is both advisable and profitable to screen the material and to remix them in the proper proportions Gravel should have no rotten stone and should be clean so that the cement may adhere to it tightly

With dirty sand no amount of cement will make strong concrete Generally sand is clean but if not it can easily be washed by playing a hose or flushing water upon thin layers of sand placed on a tight-jointed inclined wooden board In size of grain it should vary uniformly from fine to coarse All particles passing a ¼ inch screen may be considered sand Any good tasting drinking water is suitable for concrete

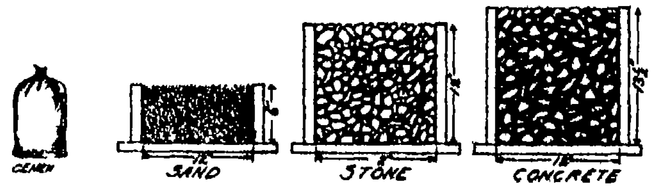
The tools and equipment necessary for making concrete in moderate quantities are already at hand on a well conducted farm or will be useful afterward for other purposes The list comprises the following and is shown in the illustration herewith

2 square-pointed paddy shovels No 3
1 round pointed tiling shovel or 1 garden spade
1 heavy garden rake
1 sprinkling can or bucket or 1 spray nozzle for hose
1 water barrel or 1 length of hose
1 sidewalk tamper or home made wooden tamper
1 sand screen made of section of ¼ inch wire mesh nailed to a wooden frame.
1 measuring box or frame. See description further along in article
1 mixing board.
2 wheelbarrows with steel trays.

For farm work the following proportions are most suitable

For concrete necessarily waterproof 1 2 4 or 1 4
For all other ordinary purposes 1 2½ 5 or 1 5

Such proportions of three parts, as 1 2 4 indicate that the concrete is to be mixed 1 part cement to 2 parts sand to 4 parts screened gravel or crushed rock and 1 4 that it is to be mixed 1 part cement to 4 parts bank run gravel



SHOWING PROPORTION OF MATERIALS USED AND RESULTING CONCRETE


VIEW OF MEN SHOVELING AND MAN RAKING CONCRETE


SHOVELING CONCRETE ON A TWO MEN BOARD


CONCRETE MIXING BOARD TOOLS ETC

Measurement by counting shovelfuls is poor and uncertain practice To avoid splitting of bags of cement make as the unit of measurement 1 cubic foot the amount of loose cement contained in one cement bag Such measurements are made a very easy matter by gaging the wheelbarrows For this purpose use a bottomless box holding one cubic foot A shallow bottomless frame is also a convenient means of measuring Such a frame when set on the mixing board and filled should contain the *full* amount of sand or *one half* the quantity of gravel, or crushed rock required for one batch of concrete

The size of the batch is dependent upon the amount of help and the dimensions of the mixing board or platform For work of ordinary size sufficient room will be had on a two-men board 8 by 14 feet, framed solidly and covered with one-inch stuff with tight joints the short way of the board. A wooden strip nailed around the outer edges will prevent the loss of liquid cement For such a board and the proportions designated above make the bottomless frame of the clear dimensions given in the table below

Table for Two-Bag Batch

Proportions	Sacks of Cement	Framefuls of Sand.	Framefuls of Crushed Rock or Screened Gravel	Clear Dimensions of Frame
1 2 4 or 1 4	2	1*	2	0′ 6 × 2′ 8′ × 3 0′
1 2½ 5 or 1 5*	2	1	2	0′ 6″ × 3 6″ × 4 0″

*For bank run gravel use the same table, but no sand is required except that which is already in the gravel.

All the materials (slightly more than the computed quantities) should be on hand before beginning the work They can often be hauled at odd times. The sand and gravel or stone should be piled so as:

To cause the least amount of wheeling

To make the mixing most convenient to the water supply

To allow room for the future location of the mixing board

If the gravel does not need screening place a bottomless frame, previously described for a 1 4 mix, on the mixing board and fill it level with gravel. Lift the frame spread the gravel slightly with the garden rake, and upon it distribute evenly two bags (the full amount) of cement. Set the frame upon the leveled surface of cement and gravel and again fill it in the same way.

Remove the frame and spread the entire mass by dragging it back and forth with the rake. Two men, opposite each other, then [illegible]

until the cement no longer shows in streaks, the mixture has a uniform color Throw up the edges, and, with sprinkling can or hose with nozzle apply water in quantity according to special directions obtainable for each particular kind of construction Turn again and add as much more water as may be required If dry streaks are still evident, continue the turning until they disappear With wheelbarrows quickly remove the concrete and immediately use it in the work

If crushed rock or screened gravel is to be used fill the bottomless frame with sand and distribute upon it two bags of cement Drag the materials back and forth with the garden rake then turn as described above until the mass has a uniform color Spread the mixture so that two framefuls of crushed rock or screened gravel may be placed upon it. Wet the mass and turn as for bank run gravel until each stone is coated with cement mortar Remove as for the gravel concrete

For the proportion of 1 2½ 5 or 1 5 the method of mixing is the same

Since c ushed stone is more or less porous in dry hot weather it is advisable to keep the stone pile wet or at least to water the stone well as it stands on wheelbarrows ready for the mixing board

No vast amount of knowledge and experience s necessary to do first-class work in oncrete. Success is dependent upon the care and thoro ighness exercised in the

Selection of the materials

Mixing of these ingredients and

Protection of the fresl ly placed concrete

The Mathematical Initiator

A Tangible Multiplication Table

A FEW years ago a French gentleman named Camescasse constructed for the edification of his children a tangible multiplication table with the aid of the one-inch cubes of the Froebel kindergarten material He has recently improved this apparatus for teaching the rudiments of mathematics by using cubes with deep grooves on two opposite sides and at right angles to each other into which can be inserted straight bands of metal which fit the grooves tightly enough to hold a row of blocks together but not too tightly to be easily removed

The improved apparatus which is sold under the name of the mathematical initiator consists of 600 white blocks 600 red blocks and 144 metal bands of various lengths The blocks measure a trifle less than one centimeter every way so that a row of d blocks with the inevitable narrow interstices between them measures 10 centimeters very approximately The grooves are 5 millimeters deep and 0 8 millimeter wide and the longest metal bands are 4 millimeters wide, 0 8 millimeter thick and 92 millimeters long Hence a band which binds ten blocks together is completely buried in them and the blocks form a smooth

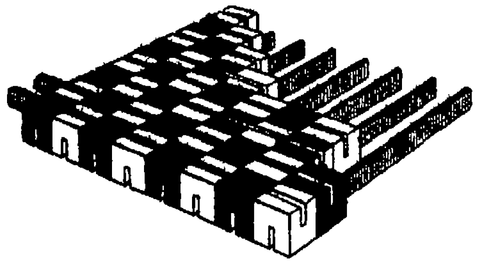


Fig. 1 —Method of assemi ling tl l locks by means of metal ban ls

square bar one decimeter in length By inserting bands in the other set of grooves ten of these composite bars can be joined together to form a plate one decimeter square as is shown in Fig 1

The mathematical initiator will be found useful in forming the designs and patterns which constitute a regular part of kindergarten work Fig 2 shows one of the vast number of patterns that can be formed of

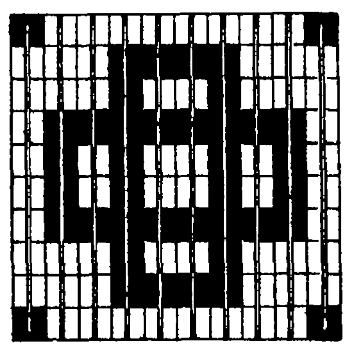


Fig 2 —A n osaic pattern

the red and white blocks assembled by means of the metal bands By handling the blocks children are unconsciously initiated into the mysteries of arithmetic and learn to count with hands and eyes before they can name or write the numerals A young child is soon taught to affix to each metal band one block for each of its ten fingers and the count can be verified by placing the fingers on the assembled blocks as on the keys of a piano Afterward the child learns to count the blocks and the bars of ten blocks Te bars of 10 can be assembled into a plate of 100 by inserting metal bands into two of the vacant grooves and 10 plates can be piled up to form a cube of 1 000 blo ks or one cubic decimeter In this way the child requires an objective knowle lge f units tens and hundreds and learns that a thousand represents 10 hundreds or 100 tens At the same time a familiarity with the metric system is acquired The child soon adopts the square centimeter as the unit of area and the cubic centimeter as the nit of volume and learns that a d imeter contains 10 centimeters a square decimeter contains 100 square centimeters and a cubic decimeter contains 1 000 cubic centimeters

More abstruse arithmetical operations can also be materialized witl the aid of he mathematical initiator Among such operations are those w ich give the squa e of the sum of n consecutive whole numbers the squa e of the sum or differen e of two numbers etc Fig 3 shows a square of red and white blocks arranged to illustrate tl e formula $(a + b + c) = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$ that is the law tl at the sq are of the sum of three nu bers is ob ained by adding the sum of the sq ares of the n l ers to twi e the s m of their prod ts taken two a d two I he example illustra d l e numbers are 2 and o the sum of which is ten A little inspection of Fig 3 shows that the large square having 10 blocks on a side is made up of three sn aller squares havi g resj ectively 2 3 and 5 on a side and of three pairs of rectangles of 2 by 3 2 by 5 and 3 by 5 but this fact is impressed on the

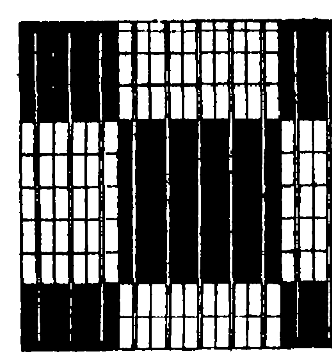


Fig 3 De str t on of formula $a + b + c) \quad a + b^2 + c^2 + 2al + 2ac + 2bc$

ch l l s mind far more firmly and in concrete form in the process of building up the large square The above ar ol ly a few of tl ed ational possibilities of the n athe atical initiator —Revue des Sciences

Problems of Existence

By Sir Oliver Lodge

IN the first of a series of three lectures just delivered on Problems of Existence Sir Oliver Lodge said that the term science might be used in a narrow or in a broad signification Sometimes the one was convenient but always the other was permissible and if the use of the term in the narrow sense tended to obscure the larger significance then in that connection such use must be deprecated It was rather commonly supposed that the region amenable to strictly scientific study was a narrow one and that it by no means embraced nor would it ever embrace the whole of possible knowledge A boundary was often drawn between tl e scientific arena, on the one hand and the literary the philosophic the religious domains, on the other But in truth no such bound ary could be drawn there were no absolute barriers or discontinuities in nature Every subject merged into, and had more or less connection with every other It was true that subjects were in very different stages of maturity more exact and precise knowledge was attainable in some of them than in others, Those subjects which in a given epoch of the world's history were susceptible of exact and demonstrative treatment—especially those which were amenable to the alternate analysis and synthesis of the Newtonian method—constituted the citadel of the scientific domain. But there were also sciences which, as yet, were almost wholly in the stage of observation and classification and any one of these might develop sooner or later into some thing more like the deductive stage as chemistry had within the last century—not only new compounds, but even new elements being predicted—and as biology had begun to show signs of doing under the stimulus supplied by the genius of Darwin and of Mendel There could be no doubt that this tendency toward advance from tl e vag e to the definite was a constantly progressive one and that departments f human experience now apparently beyond treatment by rigorous methods would gradually be incorporated and fused in the onq ered and explored territory Meanwhile they were not shut off from human scrutiny n erely because rigid treatment was not yet applicable They must be treated by methods appropriate to the stage to which our minds had risen with respect to them No contempt for such methods should be felt except when they were applied in departments wherein they had already been superseded

Some there were who regarded the scientific advance or as they called it, encroachment upon wild and unexplored territory with dislike thinking that the process would be death to mystery and would reduce all nature to matter-of fact and commonplace In geography it must to some extent be so sin e the surface of the earth was limited But those who realized the infinitude of complexity in the simplest existence and the way in which the whole of creation was bound together without barriers or bo nd aries or limitations forming one continuous and infinite whole would have no such fear nor would they think it inappropriate for a scientific man to cast his eyes around from time to time to see what new departments of knowledge might be coming within his ken Indeed they would not hesitate to welcome such advances and reach out a hand to catch as best they might some anticipatio of the interest that must thus legitimately accrue to the accumulated wealth of knowledge now within our grasp

THE PROBLEM OF EVIL.

The narrow specialising attitude was useful and had performed yeoman service. The work of the delver and digger was of tl e ut nost value but they must not through se and wont g adually acquire the notion tl at h rs was the only method of value or that the wo k of l e hun anist the inspired glea ns of the poet the g ides aval able tl ro gh the int ition an l l stin ts of humanity w re deceitful will o the wisps whi l led o nothing I'h re was room for every class of worker and tl e men of science themselves might in certain noods raise themselves out of their groove of steady work and look around as one and another had always done and tell the world what it was they saw from their point of vantage—whatever that point of vantage might be whether elevated peak or subterranean cavern For however it might be regarded by others still it was their point of view the place they had attained thro gh severe toil and it was not only their right but their duty to tel such other workers as would listen what it was that thence they saw

Sir Oliver elaborated a reasoned foundation for an optimistic attitude toward the Universe dealing with the Problem of Evil as illuminated and to some extent solved by the relativity of all things He instanced the analogy of light and shade in an engraving and pointed out how meaningless and monotonous existence would be if it were all high light He considered that pessimism if encouraged led to a kind of practical atheism and that this attitude was quite unnecessary and illogical In his treatment of evil he discriminated however between the theological problem of evil in the abstract and the h mai problem of sin or man made evil and insisted that an explanation of the one formed not the slightest justification for the other thoug by casual readers and speakers the two aspects w re sometimes confused —English Mechanic and World of Science

Marconi's Marvels Explained in a London Law Court

Messages Received in Court from Ships at Sea

By P. F Mottelay

On Monday the 12th of December was commenced in the Chancery Division at the London Law Courts before Mr Justice Parker one of the most interesting suits on record also likely to prove one of the most costly by reason of the large number of eminent counsel employed as well as of the many expert witnesses to be called and of the long time it will necessarily require to properly bring before the court all the claims of the litigants

The action is brought by Mr G Marconi and his companies against the British Radio Telegraph and Telephone Company for the alleged infringement of three patents dated 1900 1902 and 1907 Representing the plaintiffs are Mr Astbury K C Mr A J Walter K C and Mr J H Gray For the defendants are Mr T Terrell K C and Mr Colefax All the lawyers employed are well specialized in patent law

The wireless system is to be worked in court by means of the Law Courts electric current which has been tapped by leave of the Office of Works under the supervision of Prof Boys A wire attached to the complicated machinery passes through one of the windows and connects with an aerial wire fixed to the clock tower It is said that messages will be interchanged with stations at Gibraltar in the Mediterranean and elsewhere and with ships in the English Channel Some messages had already been picked up over London when the apparatus was set up the previous Saturday

The whole of the first day was devoted to Mr Astbury's opening speech which was not concluded until middle of the day following He explained that his address would be divided into four parts in an endeavor

1 To show what Mr Marconi had done apart from scientific theories

2 To put the court into possession of the scientific theories connected with this very difficult system and explain what was scientifically known before granting the patent of the four sevens

3 To explain the four sevens patent

4 To deal with the question of infringement

He then gave a short sketch of the history of wireless telegraphy describing the first beginnings of knowledge and traced the results which were obtained by Heinrich Hertz the great founder of the whole theory upon which the system has been built up and mentioned the fact that Sir William Crookes was the first who suggested the possibility of using Hertzian waves for the purpose of transmitting messages This he did in a Fortnightly article published during 1892 Two years later (1894) Sir Oliver Lodge gave a lecture at the Royal Institution of Great Britain which was by many relied upon as an anticipation of Mr Marconi's 1900 patent but erroneously said he for Lodge made no satisfactory suggestion as to how the Hertzian waves could be put into practical use, he had deflected a galvanometer needle from the distance of a few yards, and all that he had really demonstrated was the existence of the ether waves

During 1896 Mr Marconi took out the first patent ever granted on wireless telegraphy He made numerous trials and succeeded in transmitting messages in Italy a distance of 1¼ miles and, on Salisbury Plain in presence of many British officials as far as 1¾ miles In the following year, at the last named place he sent messages first 4 miles, then 8 miles, across the Bristol Channel subsequently increasing the distance to 12 and to 14 15 miles and finally covering 30 miles during the year 1899 The year before (1898) the wireless system had been installed between Osborne and the royal yacht, thus enabling Queen Victoria to maintain constant communication with the then Prince of Wales (King Edward VII) In 1899 the system was fitted on three English battleships and was sent out to the Boer battlefields as well as to the Sandwich Islands In 1900 wireless was adopted by the Norddeutscher Lloyd Steamship Company and installed on one of their largest vessels In 1901 the Admiralty obtained a license for the use of wireless telegraphy from the plaintiff company, which had four years previously been registered to take over and work Mr Marconi's patents in Great Britain It was in this same year (1901) that the wireless was accepted by the Canadian government and that the first message was transmitted from Poldhu in Cornwall to Newfoundland some 1 800 miles, which distance was increased the year after to more than 2 000 miles In 1903 an International Conference was held in Berlin at which England was represented but in consequence of England's relations with the Marconi Company that country could not assent to certain definite propositions put forward by the other nationalities

During 1904 the Wireless Telegraphy Act was passed mainly to enable the making of international agreements It prohibited the installment of the system in the United Kingdom or on British ships without the license of the Postmaster General and specified that the apparatus must be of the character described in the agreement that it must be syntonized in all British vessels that it must be so constructed as to be capable of using wave lengths of 300 meters—so as not to interfere with the longer wave used by war ships—and that the speed limit should not be less than twelve words a minute In the same year 1904 the Russian government ordered the wireless for its own purposes and used it throughout the war with Japan

Every important land station in the United Kingdom except one in Galway and one in Cornwall belonging to the Post Office, had meanwhile been prepared for the reception of the system, and during the year 1905 an arrangement was made by which the Board of Trade and the Corporation of Trinity House fitted lightships with wireless installations for the purpose of protecting the coasts. By a later agreement, it was arranged that the Post Office should acquire the land stations then being erected in order to prepare them for the transmission and reception of wireless messages. At the present time, every English battleship is fitted with the Marconi system, and not long since a message was transmitted to England from South Africa, a distance of 6,000 miles.

Mr Astbury explained how in the first half of the last century, phenomena relating to electricity were observed and gradually understood until, in the fifties, Joseph Henry first evolved the theory of oscillatory discharge of electricity, which was proven by Lord Kelvin then how Clerk Maxwell had evolved from the discovery of oscillation the newer theory that oscillatory discharges of electricity must be accompanied by wave disturbances in the ether which theory he showed was satisfactorily proven by Hertz and others Tesla, he said was the first man who drew attention to the utilization of air waves, and he then explained Lamby's invention of the coherer, by which the waves were controlled and measured and he also reviewed all other improvements made up to the present time.

By way of illustrating the principle of "the four sevens" patent (No 7 777) of 1900 Mr Astbury said that if you kept on giving a pendulum little touches with a feather you gradually get it to take long swings In the same way little waves were seen pattering up against the 'four sevens' receiver When their combined efforts reached the point to which it was tuned the messages were read. By this device messages got to their intended destination and nowhere else

With regard to the infringement, Mr Astbury argued at great length how the defendants had imitated Mr Marconi's patented apparatus, with the exception of the unimportant transformer by employing the same persistent oscillator the same aerial and the same primary in a closed circuit. He alleged that the defendants had copied Mr Marconi in every thing they had done

In conclusion, Mr Astbury stated that the two great problems Mr Marconi had had to face were

1 How to improve his apparatus so that each receiving station should respond solely to the waves from one particular transmitter or set of transmitters.

2 How to increase the efficiency of his apparatus so as to cover great distances

The Origin of Bulldogs and Pugs

The history of most of our domestic animals is shrouded in mystery The breeders of former times did not realize the importance of keeping records of their methods and results or they were too ignorant to understand just what they were doing getting results for the most part through an occasional lucky hit amidst many routine misses

A German investigator attempts to work out the history of the bulldog and of the pugdog by studying the pedigrees of dogs goats pigs and cattle that showed the characteristic shortening of the skull that distinguishes these breeds of dogs After considerable comparative study of the skulls of these mammals he concludes that inbreeding is the cause of these peculiar head formations

This view is severely criticized by biologists since it is a well known law that inbreeding never creates new characters but only intensifies old ones A more reasonable view is that which directs attention to the fact that many wild animals when caught young and brought up in confinement do not have as long heads as shown by other members of the species in the wild state A decided shortening of the bones of the face takes place in the case of the wild dogs and the wolf This is the beginning of the pug face Inbreeding develops this character It is the *method* not the *cause* says Prof Hilzheimer of Stuttgart. This scientist finds the cause rather in the modified use of the jars resulting from conditions of captivity The face he says fails to develop the same as it would in a state of nature.

The bending of the bones of the palate in these dogs is explained by the upholder of the inbreeding theory as resulting from degeneration or rachitis (rickets) due to the inbreeding Prof Hilsheimer explains this bending as due to the crowding of the teeth consequent upon the shortening of the face bones

While it is true that inbreeding can not cause the appearance of a new character it is also true that we have no evidence of any character arising as a result of changed external conditions being preserved by heredity If it is true that changes in the food have made the jaws of wild dogs under domestication fail to development, we should be able to get the original wild dog again by suitable feeding this however is impossible According to our present knowledge the probabilities are that short faced dogs like short-faced varieties of other animals arose as "sports" and were preserved through inbreeding or even had the character intensified

The Diseases of Tea

The cultivation of the plant is making considerable progress in the Caucasus region and although its introduction has been comparatively recent, it has already brought a good profit to the planters. However the tea plant is subject to maladies caused by certain parasites which prevail in these regions. A Russian scientist, M. Spiechneff, observed twelve cryptograms, and one of them, the *Pestalozzia guepini*, causes a curious disease known as the "gray malady Here the leaves show gray spots surrounded with a border of darker color. After some time there appear small dark spots which represent the fructification of the fungi. Other dangerous species are the *Dicosia Theae* and the *Capnodium footii*. This latter causes a malady known as "soot" of the tea plant, and sometimes gives much damage. Another disease is described by M Spiechneff, and it has the form of buff gray spots sometimes covering all the leaves He considers that it is caused by a cryptogram but Duconnet and others consider that the disease is not of a parasitary nature The gray malady and the soot disease attack also the leaves of evergreen plants such as the camelia, rhododendron, and magnolia, but on the contrary the former hardly ever attacks any but the Chinese tea plant, and others escape it. We may also mention that M. Voronoff observed in the Imperial plantations near Batoum, a caterpillar which bores galleries in the young tea shoots and causes much damage in this way

A Berlin inventor has recently designed a simple device for the felling of trees. The trunks are cut by the friction of a steel wire about 1 millimeter in diameter which as demonstrated by practical tests, is able to cut through a tree about 20 inches (50 centimeters) in thickness in six minutes. The wire, which is carried to and fro by an electric motor, is heated by friction on the tree to such an extent as to burn through the timber, the result being a cut which is both smoother and cleaner than that effected by saw The wire will work satisfactorily on the thickest trees without the insertion of wedges into the cut, and the trees may be cut immediately above or below the ground. In the latter case the stump may be left safely in the soil. The motor which actuates the wire is placed outside of the range affected by the fall of the tree, and when electricity is not already available it can be generated by a transportable power plant consisting of a 10-horse-power petrol motor and dynamo, which are left at the [illegible] during the felling operations.

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Welding electric L. E. Lachman [illegible]
Well drilling machine attachment G Homberg [illegible]
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A printed copy of the specification and drawing of any patent in the foregoing list or any patent in print issued since October 4th 1859 will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co. Inc 361 Broadway New York.

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Aeronautical Notes

Louis Blériot says high speed is dangerous and suggests a parachute life saver for aviators

The Journal has fixed June 4th, 1911 for the start of its circuit Paris Berlin Brussels London Paris

The newest Zeppelin, No IX," is very nearly finished It is only 430 feet long as compared to the 490-foot No VIII and the 420 foot No VII

Throughout France in retrospect of the year s progress, the words of Wilbur Wright at Auvours in 1908 are recalled These Frenchmen fly like hens chased by a dog"

The French monoplane constructors are beginning to realize the importance of building their machines so that the pilot can have a clear view on all sides and especially under him

The Wright machine of Count de Lambert which was recently fitted with a 50-horse-power Gnome engine has been ma[illegible]ellent flights at a higher speed than th[illegible] Wright.

Many of the fo[illegible]n aviators who fly Blériot monoplanes have two sets of wings for the same body one for lifting is large and quite curved while the other for racing is much smaller and very flat

The 'reefable-surface" aeroplane, which many experts consider one of the greatest developments we may in future expect seems already to be an actuality in France the Delabrosse and Christolet monoplane is so constructed that the outer sections of the planes fold back and reduce the speed from 29 7 feet to 23 1 feet

The Parseval hydro-aeroplane has created a great deal of interest abroad On October 15th it flew about three miles over Lake Plau at Mecklenburg, and when landing upon the surface of the lake was slightly damaged

Up to the 1st of December the winnings of Frenchmen in aeroplaning totaled three and one-half million francs Paulhan leading with 410 862 ($79 296) and Morane and Latham following him with about 260 000 ($50 180) each

The Astra concern are busy on two new dirigibles for the French army They are to be named the Adjutant Reaux and the Lieut Chauré They are each fitted with two Pipe 4-cylinder 110 horse-power motors driving three propellers one at the front and the other two on either side above the nacelle amidships

There are many new types of monoplanes in France noticeably the Sommer the Morane-Saulnier and the Minima The Morane monoplane greatly resembles the Blériot XI *bis*, it has a span of 32 feet, weighs 400 pounds and uses a 50 horse power Gnome motor The Minima built by the Société des Vehicules Aerien weighs only 120 pounds without the motor and has a spread of but 20 feet A 15 horse-power Anzani motor is employed

Trade Notes and Formulæ

Wax Ink for Zincography.—Carefully melt over a coal fire 3 parts of Syrian asphalt, 1 part wax, 1 part ceresine 1 part colophony 2 parts American rosin take the mixture from the fire and mix in 20 parts of oil of turpentine stirring in the meantime. To be kept in well stopped bottles.

Pipe Covering—1 5 parts syrup 2 5 parts rye flour, 10 parts loam 5 parts cows hair 50 parts fossil meal (kilselguhr) and sufficient water Over the strata applied layers of fabric are laid which are coated ¼ of an inch (5 millimeters) thick with a mixture of tar and lime (100 parts hot tar) into which is stirred 15 to 30 parts of slaked sifted lime powder

Preparation of Wax Powder—Yellow bees wax is cut into very fine shavings and protected from dust, and dried at ordinary room temperature for 10 to 14 days The wax must then be mixed in a mortar having a rough surface with an equal quantity by weight of rice starch. The mixing is effected at the lowest possible temperature without rubbing The powder mixture is finally passed through a fine tin strainer

Insulating Covering for Steam Pipes (according to Dietrich)—The cleansed pipes are coated with a priming coat consisting of 200 parts liquid water-glass, 100 parts of water 150 parts fine sand and 30 parts sifted sawdust. The covering mixture comes next, 60 parts of dry loam 8 parts sifted sawdust, 3 parts ground cork refuse, 4 parts potato starch, 4 parts potato dextrin 4 parts powdered water-glass 30 parts of water The loam must be well kneaded up with the water and add to this the previously mixed pulverized substances The paste-like mass is then spread with a trowel on the heated and primed metal surfaces, to a thickness of 3/16 to ⅜ of an inch (5 to 10 millimeters). When this layer is thoroughly dry the top coating can be repeated, until the pipe covering has a total thickness of at least two inches (50 millimeters) Previous layers must always be allowed to dry thoroughly To give a smooth finish to the final coat it must be brushed over with water, while still wet.

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GENERAL VIEW OF THE TWELFTH AUTOMOBILE EXHIBITION AT THE GRAND PALAIS PARIS

THE TWELFTH PARIS AUTOMOBILE EXHIBITION GENERAL VIEW ON THE OPENING DAY

THE PARIS AUTOMOBILE SHOW.—[See page]

Riddles of Science—New Elements in Chemistry

A Popular Talk by Sir William Crookes

By the English Correspondent of the Scientific American

At a recent dinner of the Authors Club of Great Britain Prof Sir William Crookes FRS the eminent chemist gave an interesting popular address on New *Elements in Chemistry* *In the length of his* discourse he traversed some of his own remarkable contributions to our knowledge of physics and chemistry and how such have influenced the modern trend of scientific investigation He pleaded guilty to much speculation on the nature of those complex variable and elusive mysteries that science has been accustomed to call elements

Before the eighteenth century he remarked the idea of elements was not much removed from the earth air fire and water of Empedocles—termed as the rational units and he proceeded to show that the ancients in their crude classification were not so remotely removed from the actual truth as appeared at first sight In the eighteenth century when modern conceptions of chemistry first dawned on the scientific mind the credulous chemist accepted the elements as ultimate facts In the nineteenth century scientific men gravely doubted and asked for proof of what hitherto had been taken for granted Obvious explanations he pointed out were seldom the true ones for simplicity was not a characteristic of Nature For nearly a century men of science had been dreaming of atoms molecules ultramundane particles and speculating as to the origin of matter This dream had been essentially a British dream and toward the end of the nineteenth century the notion of impenetrable mysteries was dismissed To-day we were confronted by problems and speculations concerning the ultimate constitution of the bodies we named elements

In 1879 he advanced a theory which has now been accepted that in the phenomena of the electric cathode stream we were dealing neither with solid liquid nor gaseous particles but with matter in a fourth state—radiant matter he called it then—which Sir Oliver Lodge described as something much smaller than *the atom fragments of matter* ultra atomic corpuscles minute things very much smaller very much lighter than atoms things which appeared to be the foundation stones of which atoms are composed Johnstone Stoney nearly twenty years later showed that a definite charge of electricity was associated with the ions of matter and this charge he called an electron It was later still that electrons were found to be the same as radiant matter capable of existing independently The identity of matter with electrons threw all our notions of what constitutes a chemical element into temporary confusion Chemists began to ask themselves What is the actual ultimate element? The very idea of an element as something absolutely primary and ultimate was growing less and less distinct until to-day we admitted the possibility of resolving the chemical elements into simple forms of matter or even of refining them away altogether In 1886 he ventured to revive the speculation that behind and anterior to matter was a substance (sub stans) which he called protyle By the operation of forms of energy on protyle he drew a picture of the gradual formation of the chemical elements, those of lower atomic weight *forming first then those of intermediate weight*, and finally the elements of highest atomic weight, such as uranium What comes after uranium? he asked, and he answered back The result of the next step will be the formation of bodies the dissociation of which *is not beyond the powers of our terrestrial* resources This was little more than a dream twenty five years ago but a dream which daily drew nearer to entire and vivid fulfillment Now in the twentieth century, ideas were floated which lead us *to think the old views of Empedocles might not be* so hopelessly absurd as they were considered some years ago Regarded as elementary attributes all Nature was included in the ideas of earth water air and fire The conception of solidity was embodied in the word earth water stood for the state of liquidity air represented the gaseous condition while fire stood for all forms of preponderable energy Opinions differed as to the constitution of the electron Some consider it to be an electrical charge on a material substratum others saw no necessity for the material nucleus and considered the electron to be pure disembodied electricity, thus approaching to the old idea of Buscovitch accepted by Faraday that the atom was only a center of force

But if we were dubious as to the constitution of the electron, physicists had settled many of its physical constants Taking as a standard the atom of hydrogen the smallest material body hitherto recognized the mass of the electron was 1/7000 of an atom of hydrogen and it moved with a velocity of two-thirds that of light It was easy to see that its kinetic energy was enormous equal to 3,500 000 foot tons per milligram So far he had given speculations with no apparent connection Chemists had been battering at the door of the unknown doing their utmost to get a glimpse of a few of the secrets so darkly hidden Suddenly an unexpected, almost incredible thing happened radium the epoch maker was discovered and then speculations which were drifting in chaos began to show some signs of order Radium, judged by severest chemical canons had all the attributes of a chemical element. *It formed salts* with the halogens it had a definite atomic weight it had a well-defined characteristic spectrum and it had the appearance and luster of a metal A bit of radium that would go into a thimble had almost shaken our belief in the conservation of substance the stability of the chemical elements the undulatory theory of light and the nature of electricity Radiant matter and radium had given us a new science—that of radio-activity Not only had radio-activity revealed to us the fact that the element radium was changing into helium but chemists alert to the strange metamorphosis had traced similar changes in other directions Derived elements were revealing themselves with bewildering rapidity more than twenty being known—and the cry was 'still they come

It was in the ores of uranium that radium was first discovered, and for some time they were considered to be only accidental associates later work had shown them to be interchangeable Uranium itself was undergoing slow change, passing through one or more intermediate forms into radium He likened uranium and the new bodies proceeding therefrom to a genealogical tree There were more than twenty of these new bodies, all of which deserved the appellation of elements But whereas the elements of the nineteenth century were apparently everlasting, these upstart elements had finite existences Uranium for instance has a life duration of 300 000,000 years, radium one of a few thousand years others of a few days, and so on till we came to those whose life history was rounded by four seconds Nature supplies us with facts which were riddles until the law of change was recognised. One body in its mineral ore was almost always associated with another body, sometimes in small, and at other times in larger, quantities Let no one however, contemplate wealth beyond the dreams of avarice by laying down a cellar full of lead and waiting for it to mature into silver and gold Probably the expected transmutation would occur, but its completion would require a lapse of time compared to which the 300 000 000 years' life of uranium would be a trifle

Physicists were now beginning to say that there was no such thing as matter, that when we had caught and tamed the elusive atom and split it into 700 little bits, these residual little particles would turn out to be nothing more than superposed layers of positive and negative electricity He refrained from speculating as to what would happen if some clever researcher of the future discovered a method of making these alternate layers of plus and minus cancel each other out!

It must never be forgotten that theories were more than mutable they were only useful so long as they admitted of the harmonious correlation of facts into a reasonable system Directly a fact refused to be pigeon holed and would not be explained on theoretic grounds the theory must go or it must be revised to admit the new fact The nineteenth century saw the birth of new views of atoms electricity, and ether Our twentieth century views of the constitution of matter might appear satisfactory to us, but how would it be at the close of the present century? Were we not incessantly learning the lesson that our researches had only a provisional value A hundred years hence should we acquiesce in the resolution of the material universe into a swarm of rushing electrons? He could not conclude better than by quoting some words he wrote more than thirty years ago We have actually touched the borderland where matter and energy seem to merge into one another—the shadowy realm between the known and the unknown I venture to think that the greatest scientific problems of the future will find their solution in this borderland and even beyond Here it seems to me lie ultimate realities, subtle, far reaching wonderful '

Real Wild Horses

It was the Russian explorer Prjevalsky who discovered a new and quite distinct wild horse in the Gobi Desert to the south of Mongolia. Although evidence existed that wild horses were probably as abundant in prehistoric times in the south of Europe as zebras are to day in British East Africa most naturalists believed that true wild horses with an unbroken line of wild ancestry were extinct. Hence great interest was felt in Prjevalsky's discovery Later the brothers Grum Grjimailo saw the horses in the desert and learned new facts about them

The Russians decided to capture a number of the animals and take them to Europe Their efforts were successful and several years ago a herd of about thirty of the Prjevalsky horses after much trouble were landed in Europe Most of them are still in Russia, but a few were taken to England where they are kept on the estate of the Duke of Bedford

The English naturalists did not make a scientific study of the animals in that country because the Russians have had a most thorough investigation in progress, with the advantage that nearly all the captive horses and a number of skeletons are in their hands. Very few of the English naturalists believed that they were true wild horses but looked upon them either as a kiang hybrid—the kiang being a species of ass—or as the offspring of escaped Mongol ponies.

The Russians, however, appeared to have settled the question They have proved it is claimed, by the methods of comparative anatomy and in other ways that the Prjevalsky horse has no relationship with Mongol species or the kiang but is a valid and distinct species of the genus horse without relationship to the ass although it has some features that remind one of the Asiatic ass, but even in these features, as the tail for example, the resemblance is closer to the horse than to the ass

The animals were mere colts when they arrived in Europe, and were not prepossessing, for they did not take kindly to the novel surroundings, were out of condition and had ragged coats and awkward gaits They have now reached maturity, have been well cared for and are good-looking animals.

Many naturalists hold the opinion that the domestic horse of to-day was mainly derived from three wild species, which have been named the steppe, forest and plateau varieties The Prjevalsky horse is a representative of the steppe variety

The brothers Grum-Grjimailo, who have had the best opportunity to observe this horse in its wild state say that it lives in the level districts and goes at night to the pasture-lands and drinking-places. At break of day it returns to the desert, where it rests until sunset

When there are nursing colts in the herd the animals always rest in the same place, but this does not appear to be the case when the foals become larger.

They usually walk one behind the other, so that the region where they live is [illegible]

They neigh clearly and the sound is exactly like the neigh of the domestic horse There is the same resemblance between the snorting of a badly frightened wild horse and that of domestic horses when scared.

The Mongolians have made many attempts to tame the wild horses, but in vain All efforts to tame the animals that have been taken to Europe have also failed Thus far the horse will not submit to man, is afraid of him, and cannot be rendered serviceable. Although now accustomed to the sight of human beings, the captives are very badly frightened if a person approaches nearer than two or three rods of them.

Recently the use of iron wire instead of platinum in the manufacture of electric light bulbs was forecasted by Dr. H. J. S. Sand, of the Nottingham University College. Dr Sand gave a demonstration of vacuum-tight seals between iron and glass. He announced his discovery of a method of sealing iron wire vacuum-tight in glass. Till now, he said, the only metal [illegible]

The Number of Stars in the Universe

How Celestial Bodies Are Counted

By Otto Hoffmann

One of my favorite books is Prof Newcomb's little volume entitled "The Stars," from which I have often derived both instruction and inspiration When this book was published a few years ago, certain views expressed in it created a mild sensation These views, according to which the stellar universe is limited in space and composed of a finite number of stars have since crystallized into a theory of great probability

It was always foolish indeed to assume the existence of an infinite number of stars The only ground for this assumption is the apparently infinite number of stars visible even with the naked eye Yet the number of such stars is surprisingly small The Almagest," attributed to Ptolemy which was really written by the Greek physician Hipparchus enumerates about 1 000 stars and approximately the same number is given in the catalogues compiled by the Arabian Al Sufi and by Ulugh Beigh a grandson of the famous conqueror Tamerlane These old catalogues however include only bright and conspicuous stars It is certain that a much larger number was visible to the ancient observers About 2 000 stars can be seen above the horizon at one time on a clear night by the average eye. According to Backhouse more than 25 000 stars would be visible to the naked eye if there were no atmosphere. The German astronomer Heis who possessed uncommonly keen sight published in 1872 an atlas which contained 4 943 stars visible between the north pole of the heavens and the 20th degree of south latitude This work was supplemented in 1874 by Behrmann's atlas containing 2 306 southern stars The sum of these two numbers 7 249 represents the whole number of stars that can be seen by unusually good eyes.

The number of stars revealed by the telescope is enormously greater than this The most extensive star catalogue which we possess is the work of the indefatigable Argelander of Bonn who in the middle of the 19th century indicated the places of all known stars down to magnitude 9 5 situated between the north pole and the second degree of south latitude 324 189 stars in all Argelander's work has been extended southward by his successors Schoenfeld at Bonn and by Gould and Thome at Cordoba, Argentina and is not yet quite finished The complete catalogue will give the places of about 800 000 stars as stars of the 10th magnitude are included in the Cordoba observations

All of these numbers however are very much smaller than the total number of stars actually in existence Sir John Herschel estimated that 5½ million stars could be seen with his 20-foot telescope Struve estimated the whole number of stars at 20 million Pickering thinks that more than 50 million stars can be seen with the great refracting telescope of the Lick Observatory, which shows stars of the 16th magnitude

Still fainter stars can be photographed with long exposures Dr Roberts's photographs of the sky show about 64 million stars according to Core's estimate The Carte du Ciel, the international photographic atlas of the heavens the production of which was decided upon at a congress which met in Paris in 1900 is expected to show 13 million stars although it will not include any stars smaller than the 14th magnitude The whole number of stars in our stellar system is several hundred millions according to Newcomb and a thousand millions according to Dyson

That the stars cannot be infinite in number is evident from the following considerations The fainter stars taken together emit more light than the brighter stars Hence if the number of stars were infinitely great the whole sky would appear as bright as the noonday sun In reality the background of the sky is quite dark and the total amount of light which we receive from the stars is very much smaller than that which the sun sends to the earth Prof Newcomb concluded in 1901 that the total starlight is only 728 times the light received from the star Capella or 1/89 the light of the full moon

These statements will be made more intelligible by an inspection of the following table containing the number of stars of each stellar magnitude

Magnitude	Number of stars
Between 1st and 2nd	19
Between 2nd and 3rd	105
Between 3rd and 4th	300
Between 4th and 5th	1 016
Between 5th and 6th	3 265
Between 6th and 7th	10 200
Between 7th and 8th	31 000
Between 8th and 9th	93 000
Between 9th and 10th	271 000
Between 10th and 11th	710 000

This table shows that the number of stars of each magnitude is about three times that of the preceding magnitude By continuing to apply this ratio we obtain more than 1 500 million stars between the 17th and 18th magnitudes But the light of a star of a given magnitude is not 3 times but only 2½ times greater than that of a star of the next following magnitude Hence the light received from all stars of the 9th magnitude for example is considerably greater than the light received from all stars of the 8th magnitude If the universe contained an infinite number of stars distributed among smaller magnitudes even approximately according to these laws the amount of light and of heat received from all the stars would evidently be infinitely great or at least insupportable

Struve impressed by this difficulty many years ago assumed that the light of the stars is weakened by absorption in interstellar space The value which Struve assigned to this absorption must be regarded as arbitrary and for a long time it was impossible to decide whether any such absorption occurs The recent researches of Kapteyn Nordmann and Tikhoff prove that starlight is slightly absorbed in its flight through space but the amount appears far too small to create a new basis for the assumption that the number of stars is infinitely great – Prometheus

New Discoveries at Knossos

The Remarkable Revelations of Dr Evans

By H R Hall

A LETTER has recently appeared from Dr Arthur Evans describing the results of his excavation this year at Knossos There were many more things that we wanted to know about Knossos and one of them has been made clear by the work of this season The great domed pit the *tholos* as it seemed to be over which part of the southern quarter of the palace was built, has been excavated to the bottom not without danger to the workmen And it turns out to be a great *tholos* like reservoir with a spiral staircase round the inside of it which breaks off as in other similar cases at what must have been the average water level The springs that supplied this reservoir are now dry and no doubt were so before the place was entirely filled up This was done as we know from the character of the potsherds found in it, in the first Middle Minoan age

"In other words the reservoir itself belonged to the Early Minoan Age and was filled in at the time of the construction of the first palace of which we have any existing remains—the object of the work being to obtain a secure foundation for the South Porch and adjoining parts of the outer wall The filling materials themselves were probably supplied by the leveling away at this time of the summit of the Tell of Knossos in order to gain the area for the central court of the palace." There was also a smaller reservoir on another part of the mound "and from the magnitude of the work we may well conclude that some earlier predecessor of the great palace already existed on the site that it has since occupied

This is an important conclusion. If we are to judge by the reservoir, the early Minoan palace was probably a great architectural work The Early Minoan III architects were perhaps almost as capable as their contemporaries, the Egyptian pyramid-builders of the fifth and sixth dynasties.

[illegible] small "palace" on the hillside west of [illegible] further discoveries have been made, including [illegible] way with the rut-marks of ancient [illegible] In this part of the site more recent remains of classical and Roman date constantly are found above the Minoan level whereas in the main palace whether owing to a superstitious awe or to other causes the hilltop was never invaded by later habitations A fine metope of a Doric temple contemporary with the Parthenon sculptures was found over the western palace

Mr Doll has proceeded with the work of conserving the palace buildings and has run the great staircase another flight higher Also the nature and composition of the frescoes have been studied by Mr Noel Heaton

In the tomb-field of Isopata further important discoveries have been made owing to the *flair* of Gregori Dr Evans's Cypriote foreman 'the most expert tomb-hunter of the Levant. The wild long rooted fennel which seeks out by preference the spots above ancient cuttings served him as often before as a guide and the result was the discovery of six chamber tombs some of which for their size and the interest attaching to their contents and arrangement surpass any hitherto known of this class

The date of the tombs is the second late Minoan period about 1450 B C contemporary with the eighteenth dynasty of Egypt. The most remarkable point about these tombs is the information as to Minoan religion which they give us In one tomb where the religious interest culminated was found an arrangement wholly new which rather recalled the domestic Etruscan ideas of the after life than anything yet known of the Minoan age The tomb was made to resemble a house of the living with stone-cut benches as if for family gatherings And at the head of the sepulchral cist were found the remains of a double-ax shrine with an offering vessel, in the shape of a bull's head lying close by These tomb-chambers seem not to have been kept open regularly but were opened for solemn service on the anniversary of the death probably They were rifled of their more valuable contents by robbers of the early Iron Age (geometrical period), who left behind traces by which we can identify their date

It will be seen that the Tomb of the Double Axes has produced more definite evidence regarding the sepulchral cult and religious ideas as to the after world than any grave yet opened in Crete or prehistoric Greece

Dr Evans's comparison of the interior of the tomb with that of an Etruscan grave is very apposite and suggestive This Etruscan impression has already been given by the great painted sarcophagus found by the Italians at Agia Triada and it is most interesting to see how a relationship between the Etruscan Minoan and Anatolian (Hittite) cultures in matters of religious cult is gradually becoming clearer to us —Nature

Waterproof wall paintings on a finished back ground of mortar made from lime quartz sand in fusorial earth and water are prepared as follows Painting ground Four parts of quartz sand 3 5 parts marble sand 0 5 part infusorial earth heated to redness 1 5 parts thick lime paste After drying the painting ground is to be coated with hydrofluosilicic acid and impregnated several times with potash water glass earth colors which have been digested for a long time with potash water glass are used After dilution the silicic acid is separated by means of carbonate of ammonia from the water glass which remains in intimate combination with the colors To the washed-out colors hydrate of alumina and hydrate of magnesia are added they are rubbed down and preserved in paste like condition The pictures are fixed by means of a spraying apparatus and a fluid obtained by heating 200 parts of potash water glass 100 parts caustic ammonia, 10 parts caustic potash and 12 parts marble powder and decanting this from the residue After fixation which must be done four to five times at a temperature of 100 deg to 120 deg F, the painting must be washed with carbonate of ammonia, then with water, and finally impregnated with a solution of paraffine in petroleum ether

Automatic Stabilizing System of the Wright Brothers

An Interesting Control System Devised by the American Inventors

IT IS well known that the control of the Wright aeroplane makes great demands on the attentiveness and skill of the pilot and that long practice is required in order to learn the art of steering. The steering of a Farman, Sommer or Voisin biplane can certainly be mastered in a shorter time and this may be the reason why more pilots are to be found for machines of these types. In order to facilitate the guiding of their biplane the Wright brothers have devised an automatic stabilizing system. The following description of this system is derived from the British patent 2,913 of the year 1909 and the French patent 401,905.

A flying machine is in equilibrium when the resultant of all air pressures is vertical and passes through the center of gravity. The position of this resultant, however, is dependent upon the angle which the sustaining planes make with the apparent direction of the air current which is in general opposite to

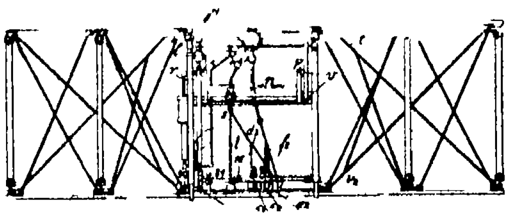


Fig 1 —Front elevation of the Wright biplane with automatic stabilizing system

the direction of flight. Any change in this angle alters both the magnitude of the resultant force and its position relatively to the center of gravity. These changes in the resultant affect the angle of incidence in turn and so the disturbing factors rapidly augment each other and the machine soon capsizes unless the disturbance is checked at its first manifestation by proper manipulation of the elevating and steering rudders and by warping the sustaining planes.

Two devices almost identical in principle and in construction have been adopted by the Wrights for the purpose of assuring an immediate and automatic restoration of the angle of incidence to the value which held the aeroplane in equilibrium on its definite course before the disturbance occurred. In one of these devices the elevating rudder is operated by an auxiliary plane whenever the aeroplane pitches or turns about its transverse horizontal axis, while the other device, which includes a pendulum, operates the vertical rudder and warps the sustaining planes whenever the machine rolls or turns about its longitudinal horizontal axis. No special mechanism is provided or required for insuring stability with respect to the vertical axis because the torque about this axis which is produced by the warping of the sustaining planes is compensated by the association of lateral steering with the warping. Zigzag flight, if it is not entirely prevented by the vertical stabilizing planes of the newer Wright biplanes, can easily be checked by hand steering before it becomes a source of danger.

The mechanism employed for the prevention of pitching is connected with the horizontal or elevating

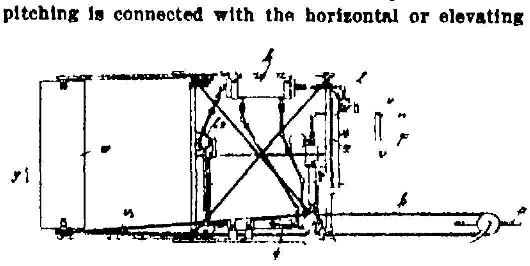


Fig 2 —Side elevation of Wright biplane with stabilizing system

rudder. This rudder a (Fig 2) is placed in front of the sustaining planes and a grooved wheel on its shaft is connected by a cord b with another grooved wheel c_1 (Fig 3) which can be turned by the hand lever d^1. The shaft of the wheel c^1 carries a loose wheel c which can be disconnected from c_1 by pressing the spring f^1. When the two wheels are connected the rudder is operated automatically by means of the mechanism now to be described. The wheel c is connected permanently by the rod g with the differential piston shown in Fig 4. The lower cylinder i in which the small head of this piston moves communicates permanently with a reservoir of compressed air by means of the inlet j so that the piston is always subjected to pressure from below. The upper and larger cylinder h can be put in communication with the reservoir by means of the inlet j_1 and the three-way cock shown in Fig. 5, which can also be adjusted to put the cylinder h in communication with the atmosphere or to isolate it completely and thus to stop the piston. These connections are made possible by the arrangement of the channels of the three-

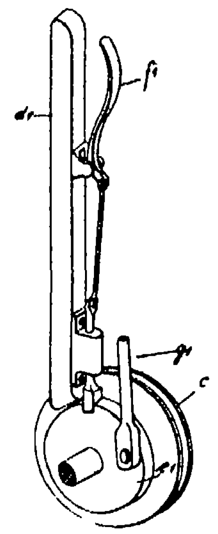


Fig 3 —Handle of elevating rudder

way cock as will appear on inspection of Fig 5. The three-way cock is turned by the movements of an auxiliary plane, the arrangement and the operation of which are illustrated by Fig 6. The auxiliary plane n is attached to the vertical arm p. The ends of this arm are connected by hinges to the outer ends of two equal and parallel arms vv whose inner ends are similarly connected to the rod r. The weight of the plane and the arms is balanced by a counterpoise attached to an extension of the lower arm v. The vertical movement of the plane is limited by the stops q. When the plane is depressed to its lowest position, indicated by the dotted lines in Fig 6, by air pressure from above, it turns the three-way cock l into such a position that the large differential cylinder h is put in communication with the outer air through the channels m and m_1 (Fig 5). The piston (Fig 4) is consequently forced upward by the excess of pressure in the lower cylinder i (which communicates permanently with the compressed air reservoir). As the piston rises it draws upward the connecting rod g (Fig 3) and thus turns the wheels c and c and by means of the cord p (Fig 2) gives the elevating rudder a an inclination which causes it to lift the bow

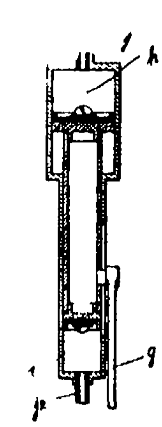


Fig 4 —Differential cylinder

of the aeroplane. The opposite effect, depression of the bow, is produced automatically whenever the auxiliary plane n (Fig 6) is forced upward by air pressure from beneath so that it turns the three-way cock to a position in which the tubes j and j_1, leading respectively to the compressed air reservoir and to the upper differential cylinder, are connected by means of the channels m_1 and m_2 (Fig 5). The piston is then forced down in consequence of the inequality in area of its two heads.

Let us now see in what conditions the auxiliary plane is impelled to produce these results. The auxiliary plane is inclined to the principal sustaining planes at an angle which the inventors call the critical angle of incidence and which is equal to the angle between the sustaining planes and the apparent air current or relative direction of motion. Hence, when the aeroplane is moving forward without disturbance the relative air current is parallel to the auxiliary plane, which consequently remains at rest in its neutral or middle position. If, however, the inclination between the sustaining planes and the relative air current becomes less than the critical angle, and the machine tends to fall in consequence of the diminution of the vertical component of the air resistance, the auxiliary plane is forced down causing the differential piston to rise and turn the elevating rudder upward. If the three-way cock and the arms which carry the auxiliary plane were attached directly to the frame of the machine the critical angle of incidence would be invariable and an arbitrary and a uniform elevation or depression would be produced by the device. The arms and the three-way cock, however, are attached to the rod r (Fig 6) which is suspended from the frame by a hinge at s. The magnitude of the critical angle is determined by the position of this rod relatively to the frame and sustaining planes, and this position can be varied by means of an adjustable clamp at y. In ascending, for example, the rod r is swung backward in accordance with the increased

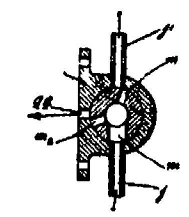


Fig 5 —Three way cock

angle at which the relative air current strikes the sustaining planes and the angle of ascent is maintained constant by the automatic operation of the auxiliary plane and its accessories as long as the rod r remains clamped in this position. The practical efficiency of the device, especially in variable winds, can be demonstrated only by experiments of which no account has yet been published to the writer's knowledge. The inventors admit that the disturbing influences are not exactly compensated but that the auxiliary plane and the elevating rudder are first moved too far and oscillate before they settle down into their new positions. In the writer's opinion periodical gusts of wind might do more damage with this device than without it.

A simpler form of the apparatus is shown in Fig 7. Here the auxiliary plane n is attached directly by a hinge to the frame of the machine while an additional positive or negative angular displacement can be given to the three-way cock l, by means of the lever r.

The apparatus employed by the Wright brothers for the purpose of assuring stability with respect to the longitudinal axis is very similar to the device described above. It includes a differential cylinder with its smaller chamber in permanent communication with the compressed air reservoir, with which the

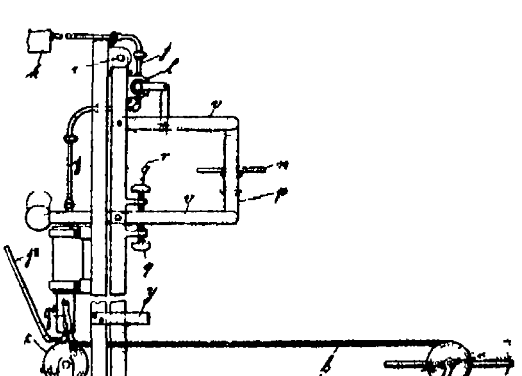


Fig 6 —Side elevation of fore and aft stabilizing mechanism with auxiliary plane

larger chamber can be connected by means of a three-way cock. Here, however, the three-way cock l_2 (Fig 8) is operated by a pendulum t. The manner in which the warping of the sustaining planes and the turning of the vertical rudder are automatically produced is illustrated by Figs 9 and 10. The hand steering lever d_2 (Fig 9) is attached to a grooved wheel c_2 mounted on the lower sustaining plane to the left of the pilot, which is connected with the loose wheel c^2 except when the bolt w (Fig. 10) is drawn back by pressing the spring f_2. The loose wheel c_2 is permanently connected by the rod g_2 with the differential piston, while the grooved wheel c_2 is connected by the cord v_1 with the warping cord v_2, which runs to the tips of the sustaining planes. The vertical rudder x is connected by the cord v_3 with another grooved wheel c_3, which can be connected with the shaft by the friction clutch u and which is also provided with a hand lever d_3.

If the aeroplane rolls so as to raise one end of the sustaining planes, as in Fig 8, the pendulum t swings to the opposite side and turns the three-way cock l_1 so as to produce an excess of pressure in one chamber of the differential cylinder, causing the piston and its connecting rod g_1 to move either forward or backward The result is that the warping cord v_2 is pulled to right or to left by the cord v_1, twisting the tips of the sustaining planes, and that the vertical rudder is simultaneously turned by the cord v_3 to an extent sufficient to counterbalance the horizontal torque produced by the warping of the planes In this case

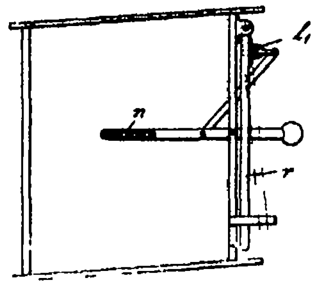


Fig 7 Simplified arrangement of auxiliary plane

also the disturbing influence is not counteracted exactly and instantaneously but the pendulum and the rudder perform a number of oscillations before they come to rest in their positions of equilibrium

In beginning a curved flight the friction clutch is loosened and the rudder is turned by hand independently of the warping of the planes If the friction clutch is then tightened with the rudder in an inclined position the machine will continue to fly in a curve and the automatic mechanism will act as efficiently as it does in pursuing a straight course

It has already been remarked that no experiments made with these stabilizing devices appear to have been published Is this because the Wrights are overwhelmed with orders or because the expectations founded on these devices have been disappointed? If the devices had proved their practical efficiency it would certainly be to the interest of the Wrights to exploit an invention which was announced in the United States in the beginning of the year 1908

In the writer s opinion the influence of the pendulum must be eliminated in curved flight as otherwise the warping effected by hand which depresses the side nearest the center of curvature of the path would be counterbalanced by the action of the pendulum swinging outward in obedience to centrifugal force The loosening of the friction clutch at a moment when the attention of the pilot is fully occupied is a serious defect of the pendulum apparatus

The Manufacture of Hydrogen

There has been a large increase in the manufacture of hydrogen within recent years due principally to three causes—(1) the construction of dirigible balloons (2) its use in the manufacture of tungsten filaments for electric lamps and (3) the oxyhydrogen blow pipe flame The demand for the gas in connection with dirigible airships and the manufacture of lamp filaments seems likely to increase very largely in the near future and it is therefore opportune at the

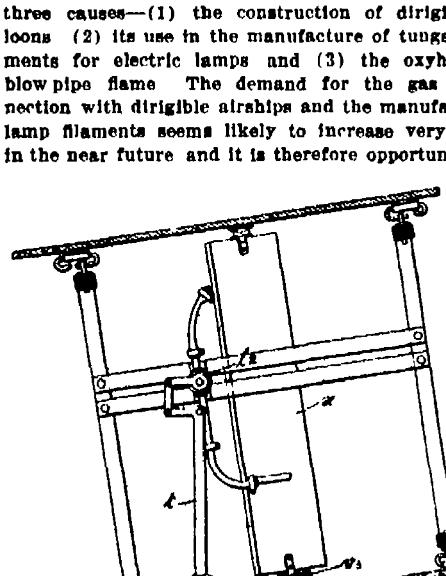


Fig 8.—Front elevation of transverse stabilizing mechanism with pendulum

present time to examine the present sources of supply and the methods of manufacture employed

Hydrogen, which is about 14 39 times as light as atmospheric air, has a much greater lifting power for aeronautical purposes than coal gas, although in point of cost the latter compares favorably The chief drawback of the use of hydrogen for inflating balloons is its high rate of diffusion, which is 3.88 if the rate of diffusion of air be taken as unity. Although this drawback is being minimized by improvements in the [illegible] fabrics, it is highly important for the maintenance of large dirigible balloons to be assured of a regular supply of pure hydrogen gas

The manufacturer of tungsten filaments for metallic filament lamps requires a regular supply of hydrogen to prepare the inert atmosphere in which the filaments are heated to a high temperature during the final treatment There is some doubt whether the hydrogen is really inert in this operation and in those cases where a carbonaceous binding material is employed the hydrogen probably assists in the complete removal of the carbon it having been shown that carbon unites slowly with hydrogen to form methane at a temperature of about 1 000 deg C (1 832 deg F) However this may be it is the almost universal custom to employ a mixture containing approximately equal proportions of hydrogen and of nitrogen when the filaments are heated to a white heat by the passage through them of an electric current during the sintering operation Since tungsten filaments when heated to incandescence are extremely sensitive to oxidation it is of great importance that the hydrogen employed should be of a high degree of purity

For the autogenous welding of metals the working of platinum and the manufacture of laboratory utensils and mercury vapor lamps from fused quartz hydrogen in the form of the oxyhydrogen blow pipe flame is used in large quantities although here it has to meet the competition of acetylene a gas which is cheaper and readily obtainable as required from calcium carbide

The preparation of hydrogen by the action of dilute sulphuric acid upon metallic zinc like most of the other methods usually employed in the laboratory for

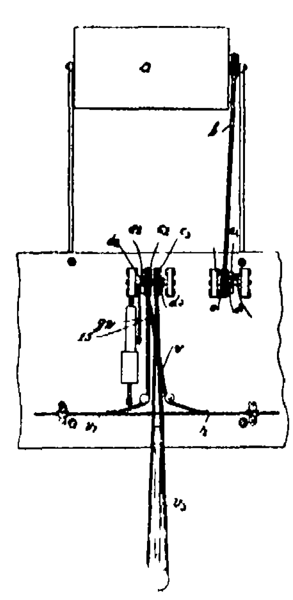


Fig 9—Plan showing elevating rudder and its connections above and vertical rudder and its connections below

this purpose is too costly to be capable of being carried out on a large scale

During the Russo-Japanese war the balloon corps of the Russian army are stated to have been equipped with a portable hydrogen plant consisting of generators in which the gas was produced by the action of a concentrated solution of caustic soda upon aluminium shavings This method has the advantage of readily yielding a plentiful supply of hydrogen in a state of high purity from apparatus and materials of small bulk but it is much too expensive to be capable of extensive application Experiments have been made at Bitterfeld in Germany with a compound calcium hydride prepared by passing hydrogen gas into molten calcium metal This substance is very similar in its behavior to calcium carbide and on treatment with water spontaneously gives off hydrogen in the same way as the carbide yields acetylene Little is known concerning its cost of production but if it could be produced on a commercial basis it would obviously possess great advantages as it would overcome the necessity of transporting the gas in compressed form in steel cylinders Frank of Berlin has patented a method of producing hydrogen by passing water gas over heated calcium carbide This absorbs nitrogen at a temperature of 300 deg C (572 deg F) and by removing oxides of carbon with suitable reagents hydrogen gas suitable for inflating balloons can be obtained

These processes are interesting from a theoretical point of view and are merely instances of the large amount of experimental work which has been carried out with a view to providing hydrogen for commercial use on a large scale At the present time most of the hydrogen used for inflating the gas bags of dirigible airships is produced either electrolytically or by the action of steam on red hot iron turnings

The electrolytic process has been developed to a considerable extent in Germany and is an application on a large scale of the well known decomposition of water into hydrogen and oxygen by means of an electric current It depends for its success upon a cheap supply of electric energy and as for every two volumes of hydrogen there is simultaneously produced one volume of oxygen this is also a source of profit The plant requires comparatively little attention and the hydrogen may be generated in a condition of great purity

The other method has been developed in this country by Howard Lane In this process steam is passed over red hot iron whereby hydrogen is produced and the metal converted into oxide The oxide formed however can be reduced again to metallic iron by passing water gas coal gas and other gaseous fuel into the

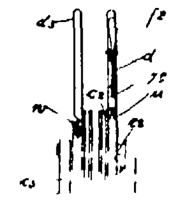


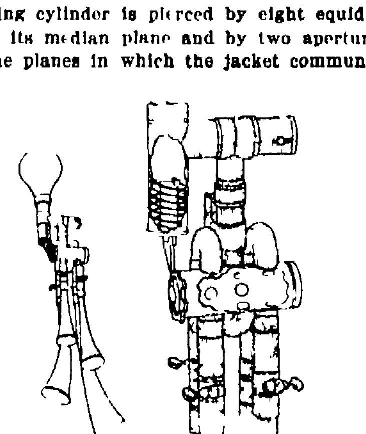
Fig 10—Wheels and levers for controlling vertical rudder and warping sustaining planes

retorts By employing a number of retorts some of which are producing hydrogen while in others the oxide is being reduced it is possible to arrange for a more or less continuous supply of gas Lane s process has found favor with manufacturers of tungsten lamps because it is also possible to arrange the plant so that when the oxide is being revivified nitrogen can be collected it being customary for the lamp filament makers to employ a mixture of hydrogen and of nitrogen

The various methods of producing hydrogen on a large scale have occupied the attention of the war departments of several governments as well as that of the aeronautical societies and the great progress which is now being made with dirigibles is bound to act as a stimulus to greater activity among chemists and engineers engaged on this problem There is undoubtedly much to be done before aeronauts can be sure of the immediate delivery of hydrogen in sufficient quantities to meet their requirements—London Times

The Testophone

The testophone is a new automobile horn so contrived that the monotonous repetition of the same sound is avoided A blast of air forced into a pump barrel by compressing an India rubber bulb moves a piston the rod of which carries a pawl that engages with a ratchet wheel of eight teeth attached to the end of a horizontal cylinder which is capable of rotation inside a fixed cylindrical jacket The cylinder is thus turned through one-eighth of a revolution each time the bulb is compressed An air pipe connects the middle of the pump barrel with the middle of the jacket of the rotating cylinder and the jacket communicates also with four horns of different pitches by means of four outlets distributed above and below its axis and to the right and left of its median plane The rotating cylinder is pierced by eight equidistant orifices in its median plane and by two apertures in each of the planes in which the jacket communicates



THE TESTOPHONE

with the horns As the cylinder rotates its eight median apertures are brought successively opposite the air inlet of the jacket and it is put into communication successively with the horns by means of its lateral openings which are so arranged that no two horns are sounded simultaneously, and each horn is sounded twice in the course of a complete revolution—La Nature

Drawing Points of Waxed Charcoal—Well burned lime tree wood charcoal is cut into the form of the ordinary sticks which must be laid in melted wax and left there about 15 to 20 minutes Take them out, dry them between blotting paper remove adhering wax and rub them off with flannel rags

Disposition of Garbage in Various Cities

The Installations of Some European Communities

HAMBURG *

In the northern and northwestern sections of the city of Hamburg garbage and house refuse are collected and carted to districts beyond the city boundaries to be spread over fields and eventually to be plowed under as fertilizing material In the central eastern and southern boroughs including the harbor such material after being collected is incinerated in a municipal establishment commonly regarded as a model of its kind and one which has given perfect satisfaction during the entire fourteen years of its practical use I am convinced that American municipalities can study profitably the experience of Hamburg in this very important matter

The refuse reduced to ashes in the municipal plant is conveyed thither in 4 wheeled water tight iron carts each of which has a capacity of about 4 cubic meters (141 cubic feet) The cart bodies can be lifted from the wheels by means of electrical traveling cranes and the contents discharged directly into the furnace There are 36 of these furnaces built according to the method of a firm in Leeds England all of which burn continuously except when they require cleaning When the fires are once started no commercial fuel is required and therefore the consumption of coal in the plant is insignificant

The slag is removed from the furnaces in small iron carts and conveyed therein to a cooling apparatus where the contents are sprinkled with cold water and then to the slag breakers which are capable of producing broken slag in three sizes in the following proportions 16 per cent passing through a 5 millimeter mesh screen (0 197 inch) 50 per cent passing through a 2 millimeter (1 inch) mesh screen 34 per cent passing through a 60 millimeter (2 36 inch) mesh screen An electric magnet is in operation in connection with the slag breakers and it removes small pieces of iron the larger pieces having been removed from the refuse before passing into the furnaces or if such are contained in the slag they are thrown out of the rotary sieve drum at the lower end of the breaker

The scrap iron recovered is sold at public auction and the slag itself is disposed of at a fixed price of 23 8 cents per ton of 1 000 kilos (2 204 6 pounds) There is always a great demand for this slag for which there are numerous applications The fine cinders are used as a top dressing for promenades the coarser grade for establishing the drainage foundation of roads and the middle size for the top dressing of roads Used in this way garbage slag is cheaper than any substitute material and it serves its purpose perfectly It is used advantageously in mixing concrete 5 parts of coarse slag 1 part of cement and 3 parts of sand being the ordinary proportions or 1 part of cement and 7 parts of middle sized slag

The very fine garbage slag may be utilized wherever coarse sand can be used for example to form a bed for street paving blocks for the manufacture of slag bricks as antislipping material on city streets in winter and as filling material in buildings under floors and over ceilings Many other uses could be named

As a filling material between floors and ceilings this slag is used very extensively in docks and warehouses of Hamburg for the particular reason that it is absolutely sterile and unlike other kinds of slag contains no sulphur by which merchandise in storage is sometimes damaged

The garbage incinerating furnaces furnish sufficient power to drive all the electrical machinery in the establishment to operate the cranes slag breakers and light plant furnishing also electricity for the accumulators of an electric motor launch and an electric motor cart used in the transportation of garbage At present only one motor cart is in use and it is proposed to purchase a number of others so that within a few years horses will be eliminated entirely in the handling of garbage

Such city garbage as is not burned is utilized frequently to fill up marshes and swamps as well as for fertilizing purposes

Contracts for the removal of garbage whether for destruction by fire or for other disposition are awarded by the government to private firms upon public tenders and in several lots described according to the distances to be covered in transporting the refuse Two firms for years have secured such contracts These own the necessary horses and stables and rolling stock and furnish the men the carts in which refuse is conveyed to the incinerating plant are municipal property placed at the disposition of the contractors Having very considerable outfits, the two firms seem also to control the transportation of sand gravel, paving stones, and bricks within the city

The present contracts for the removal of garbage were made in 1905 for a period of five years The city pays $107 to $132 according to distance, per 1 000 inhabitants served (The city of Hamburg has a population of 895 804) New contracts were made this year with the same firms, according to which the contractors will receive $136 to $202 per 1,000 inhabitants but these contracts are to run for two years only, for the reason that a second incinerating plant is in the course of construction and will be ready for use within that time.

The new destruction plant is being arranged much like the old one except that the experience of fourteen years has been utilized and instead of Horsfall furnaces the so-called Hamburger Öfen will be employed The new ovens are not unlike the Horsfall ovens but are believed to have been improved upon to such an extent that whereas the Horsfall furnaces can dispose of only 9 tons of material per twenty four hours the new ovens will dispose of from 22 to 25 tons during the same period

Householders in Hamburg are required to provide themselves with metal receptacles, which they place upon the curb line usually twice a week between 8 and 9 o clock P M The garbage gatherers empty the cans into their carts between 9 P M and the early morning hours The cans themselves are very seldom stolen and it is possible and indeed quite common to purchase numbered cans from private firms which if stolen are replaced by the insuring firm

The conditions in Hamburg are such that ordinary householders reduce the amount of garbage to be carted away as much as possible by destroying in kitchen stoves everything that can be burned

LONDON *

Acting on the request of American firms special inquiries were directed to the engineers of several of the boroughs of metropolitan London for securing information regarding the collection and disposal of garbage The substance of these replies is as follows

In the borough of St Pancras the collection of all garbage is supervised by officers in the direct employ of the borough council The collection of house refuse is carried on by a staff in the direct employ of the local authority The collection of street refuse is also made by the council s own staff but its removal from the streets is effected by contractors In the letting of contracts no distinction is made between individuals and corporations

The borough is divided into eight wards for which separate bids are received though sometimes more than one ward is given to a single contractor The contracts are for twelve months on a lump-sum basis —that is each bidder offers to remove the whole of the street refuse in any ward for a stated sum

For the removal of house refuse dust vans of 5 cubic yards capacity are employed two men accompanying each van Nearly all of the houses have portable dust bins which are carried out by these men and emptied into the van In a few cases there still remain fixed dust bins from which refuse has to be shoveled into baskets and carried to the dust van The collection generally proceeds all day from 7 A M to 5 P M but in certain main streets police regulations forbid dust vans to carry on their work after 10 A M and in these streets daily collection is made between 7 A M and 10 A M the residents being required to bring their dust receptacles to the footway

In the case of hospitals, large hotels and large restaurants daily collection is made and in some of the more densely occupied localities the collection is made three times or twice a week, but generally throughout the borough the collection of house refuse is made once a week No machinery is used in the disposal of the refuse The larger part is burned, while the remaining part is sent away by canal barges. The street refuse becomes the property of the contractors who remove it, and it is disposed of as they can best arrange It is nearly all sent away by barge on canal or river

In the borough of St Marylebone it has been the custom of the council to have house refuse collected and disposed of by contract. Bids are invited by public advertisement and the lowest bid is accepted, provided the council is fully satisfied, after inquiry, of the substantiality of the firm whose bid is proposed to be accepted The council accepts the bid for one, two, or three years, as it considers best. The cost of the work during the fiscal year ended March 31st, 1910, was $51,966.

Horse-drawn carts and vans are used for the collection of garbage, and the receptacles for carrying the refuse from the premises to the vans have to be approved by the medical officer of health. Strong wicker baskets or metal receptacles are used for this purpose The contractors collect the refuse during the whole of the day except in special streets, where the occupiers are required to place the refuse on the curb in proper receptacles before 9 A. M and the contractors are bound to remove it by 10 A. M

The refuse is taken away by barge on the canal, and while the paper and garbage is burnt the siftings of the refuse are used for brick making

In the borough of Islington the collection and disposal of garbage is undertaken by a department of the council s staff under the control of the borough engineer For this purpose the borough is divided into districts, each district, containing about 2 400 houses being served by a gang consisting of four dust loaders (one of whom acts as ganger"), three carmen, and three vans The several districts are divided into sections so that the houses of the several sections may be collected from on given days during the week and the occupiers are thus aware of the day of the week when the cart or van may be expected Householders as a rule are required to provide one or more movable receptacles constructed of metal of a capacity not exceeding two cubic feet each but sufficient to contain a week s accumulation of dust. The time of collection is from about 7 30 A M to about 5 30 P M, daily This system has been in force in this borough since 1895 and upon the testimony of the town clerk, is said to work very satisfactorily

The refuse from restaurants and eating houses if likely to become a nuisance when allowed to accumulate is collected two or three times weekly and in exceptional cases every day Trade refuse, which is defined in the public health (London) act of 1891 as meaning the refuse of any trade manufacture or business or of any building material ' is collected by special carts the charge being 2d (4 cents) per basket full

The refuse both house and trade, is carted to the council s depots adjoining certain railways passing through the borough and is tipped into railway trucks and conveyed to farmers and others along the line The council pays a small sum toward the cost of the railway rates The council has no dust destructors

In the borough of Paddington the garbage of about nine-tenths of the area is collected by the borough council and the remaining one-tenth by contractors. The contracts are let to individuals for a period of three years for a lump sum per annum The garbage is collected by horse-power covered tipping vans usually between the hours of 6 A M and 6 P M The garbage is removed by barge along the canal by the contractors The town clerk advises that machinery was abandoned several years ago

The by laws (ordinances) which govern the several borough councils are passed by the London county council a body which has jurisdiction throughout metropolitan London a copy of whose ordinances now in force for the public health is forwarded (and obtainable from the Bureau of Manufactures)

LIVERPOOL *

The work of collection and disposal of refuse in Liverpool is done entirely by the corporation of the city with direct employment of workmen and not by contract.

The total quantity of refuse collected per day in Liverpool is approximately 1 000 tons Combustible refuse is collected and destroyed at the corporation s destructors in the process of which steam is generated for various purposes The clinker residue from this operation is utilized for the manufacture of concrete slabs and making concrete for foundations, bricks, mortar etc The refuse collected from the streets of a manurial nature is graded and sold for agricultural purposes, according to the quality, In this material is included the refuse from fruit markets etc. Fish garbage is collected and disposed of for the manufacture of a patent fish manure. Old tins are separated and disposed of by being pressed by hydraulic machinery into billets and sold.

A separate class is made of waste paper, which is made up into bales and sold to paper manufacturers for repulp Oyster shells are collected, and after grinding utilized as poultry gravel, Incombustible material and garbage of no value is conveyed to sea by steam hopper barge and tipped in deep water

EDINBURGH.†

All refuse in Edinburgh is collected and disposed of by the municipal cleaning department. There is a daily removal system, the work of collection beginning every week day at 7 A. M A city ordinance provides that "any straw, chaff, ashes, dust, or house sweepings, or any offensive matter or thing" [illegible] be placed on a street or court [illegible] other [illegible] that [illegible]

* From Consul-General Robert P Skinner

* From Consul-General John L. Griffiths.

[illegible]

be placed on a street or court tied in a bundle, or after it has been reduced to pulp, and in the latter case the pulp must be contained in pails buckets, or other suitable vessels," that the time during which any of the above-specified material may be so placed on any street or court "shall be between 6 30 A. M on any lawful day and the time at which the collecting cart may on the same day, pass on its round, that vessels placed on a street or court must be removed therefrom within half an hour after their contents are emptied into the dust carts The penalty for each contravention of this ordinance is a fine not exceeding £5 ($24 33) or in default of payment imprisonment

All kinds of garbage ashes etc may be put out together in the same pail or box Street sweepings are collected separately from other refuse as is also stable manure

The number of workers in the cleaning department is 581 men and 54 boys who average about $6 10 and $3 per week of 52½ hours respectively A week s vacation in the year with full pay is allowed The total quantity of refuse (not including mud sand etc from macadamized roads) dealt with in the year ended May 15th 1909 (the latest period for which statistics are available) was 124 915 tons of which farmers took 21 631 tons (street sweepings and stable manure) and a destructor consumed 15 416 tons the bulk of garbage and other refuse being deposited near oil shale mines 7½ miles from the city limits to restore the level of the arable or pasture land

The destructor which takes the refuse from a small district is simply a furnace reducing everything to ashes or into the form of clinker this latter residuum being sold to builders and others in small quantities or when no demand exists dumped with the ashes into places in process of leveling up Into such places are also dumped all the mud sand etc from macadamized roads amounting annually to about 30 000 tons

The cleaning department received from farmers in the period mentioned $3 031 for street sweepings and $1 684 for stable manure delivered by rail On this material the railway freight alone was 16 cents per ton and on the refuse taken to the oil shale district the freight was 20 cents per ton At the destructor the disposal cost was 63 cents per ton Deducting revenues derived from the sale of manure clinker old tin cans etc and from special cleaning services at the city slaughterhouses and markets amounting in all to $16 997 the net cost of cleaning the streets and of collecting and disposing of refuse was $244 051 The average net disposal cost rate for refuse mud sand manure etc, taken together and totaling 184 930 tons was 22 cents per ton

There are some exhausted limestone quarries in the city s possession bought for the purpose of depositing garbage and other refuse on a tract of 115 acres called Burnhouse farm, 10½ miles from the municipal boundary I am informed by the chairman of the cleaning and lighting committee of the town council that in a short time the city will probably have these in use and it is thought they will prove to be the best and cheapest method of disposal

GLASGOW *

The collection and disposal of garbage is under the direct supervision of the superintendent of the cleansing department of the corporation The contract system, established in 1862 continued for six years when the entire cleansing work was assumed by the city authorities In the course of time privies and wet ash pits were abolished in favor of water-closets and dry ash pits. Power to close up all ash pits and replace them with portable galvanized bins was obtained under the building regulations act of 1900 In that year the change from ash pits to portable bins was commenced and up to May 31 1909 11 906 pits have been abolished and replaced by 39 365 bins Under the act property owners are required to abolish their ash pits also to pay for the bins and their maintenance

The refuse is now conveyed direct to a covered cart from the bin thus avoiding the pollution of the atmosphere and the nuisance of light material being scattered by the wind Refuse dispatch works and destruction furnaces were gradually erected for the disposal of refuse and the unsightly and unsanitary gigantic heaps of accumulated filth in the open depots soon disappeared

At the nine dispatch works the refuse is treated mechanically The portions fit for sale as manure are separated from the lighter and unsalable parts which are cremated in furnaces designed for the purpose The process of treating the refuse at the works is briefly as follows

Great quantities of soft sweepings require to be dealt with in wet, dirty weather These sweepings are tipped into brick built tanks with sloping bottoms fitted with perforated draining plates so that in the course of a few days the material which is chiefly composed of horse manure mixed with other refuse becomes solid enough to be transferred to a railway car

The domestic refuse is discharged from the carts through apertures in the floor into revolving screens fixed horizontally A mixing machine beneath catches the finer parts of the refuse that pass through the screen

Dry sweepings from paved streets are screened and mixed in a similar manner and from a tank above a regulated quantity of excrementitious matter passes into the mixer and when all is thoroughly blended it falls into a railway car on a siding below The coarser parts of the refuse are forced from the screen by the revolving process onto an endless carrier which drops them to a range of furnaces on a lower level As the carrier passes on everything of value is picked off such as scraps of iron wire bottles glass bones rubber tin cans galvanized and enameled ware etc The corporation owns 700 railway cars which they use for the conveyance of the city refuse over the various systems and this process of separation is in operation at 4 stations

The total quantity of material collected and disposed of by the department during the year ended May 31st 1909 amounted to 358 972 tons 8½ hundred weight The revenue derived from waste materials taken from city refuse and scrap from workshops and stores during the year ended May 31st 1909 was Clinker $81 916 tins and galvanized buckets and light iron $26 249 scrap iron $38 67[illegible] waste paper $32,694 bottles $1 279—total $180 81[illegible]

Prior to 1897 clinker was considered to be of no value and was trucked into the country at a cost of 24 cents per ton Introducing it to builders for concrete work resulted in creating a demand for clinker for that purpose The revenue from clinker alone has grown from $1,200 in 1897 to $8 895 in 1909

Old tins and galvanized and enamel articles which in previous years gave great trouble and annoyance to the cleansing department now produce a substantial revenue annually All old tin articles are now detinned and the remaining steel is pressed into solid billets by hydraulic power

At each station there is an inexpensive brick built furnace for removing the tin and solder The material is then conveyed in a motor vehicle to a hydraulic press and pumps at one of the stations where it is pressed into billets In the process of cremating the refuse more than sufficient power is generated to drive the clinker crushing machinery and to furnish electricity for lighting the destructor stations stables and offices

In 1900 the system of collecting waste paper by means of old bags issued to business premises and better class dwelling houses was inaugurated By this method the paper procured is clean and consequently more valuable than that taken from dust bins and to a great extent obviates the nuisance connected with its removal The revenue from this source has grown in ten years from $580 to $1 [illegible]00 This is a remarkable increase in view of the fact that private firms paper stock merchants are competitors of the corporation

In fifteen years the total revenue from the utilization of waste products has increased from $1 000 to $22 [illegible]00 All domestic refuse and garbage from hotels restaurants etc in the city are collected during the night concurrently with the street sweeping done by the sweeping machines There are bins sunk in the pavement at regular intervals in which are deposited the sweepings of the day staff These bins are emptied nightly and the contents together with the sweepings left at the street side by the sweeping machines are carted away

Private streets and back courts after being swept when required are cleansed by use of 1½ inch hose attached to the street fire plugs The court washings in the city average over [illegible]0 per day The proprietors of these properties are assessed 2 cents per $4 86 of the annual rental to meet the expenses of this work

After a heavy snowstorm in order to avoid disorganization of the street traffic and great inconvenience to the public the snow must be removed without delay consequently at such times great activity prevails in the cleansing department Salt is used to melt the snow on the tram tracks and is followed shortly afterward by the sweeping machine which spreads the brine created by the action of the salt on the snow over the entire width of the street thereby rendering it possible to clean the streets quickly The snow and slush is then rapidly carted and tipped into the rivers Clyde and Kelvin or the most convenient of the various tips around the outskirts of the city

In general the cities and towns throughout Scotland have well regulated cleansing departments similar to that of Glasgow with the exception that the smaller towns and villages have no furnaces for destructive purposes Some consume their garbage at county furnaces and others are obliged to cart it into the country

The city of Glasgow with its population of over 8[illegible]0 000 is perhaps all things considered one of the best cleansed cities in the world It has an excellent up to date sewerage system an abundant supply of pure water and its municipal government is of high order

* From Consul J N McCunn

A Four-Carbon Arc Lamp for Triphase Circuits

In 1904 Mercanton invented an arc lamp consisting of three specially devised and non homogeneous carbons connected severally with the three wires of a triphase circuit

Bentiroglio and Siciliani have studied three types of triphase arc lamps regulated by two magnetic fields rotating in opposite directions

Righi has recently invented a new type of triphase lamp, which produces a very constant and effectively distributed light, without the employment of complicated regulating devices Three carbons about 1/25 inch in diameter are mounted vertically with their points up so that they form the edges of a triangular prism, the base of which measures about 3/5 inch on each side Each of these carbons is connected to one of the three wires of the triphase circuit Above these three small carbons a fourth carbon about 1 inch in diameter is suspended so that its axis coincides with that of the prism As this arrangement allows the three lower carbons to make contact simultaneously with the upper carbon it is easy to establish three arcs, arranged radially and six craters The greater part of the light of an arc lamp is emitted by the craters. In the Righi triphase lamp, owing to the position of the three upper and more [illegible] craters most of the light is radiated downward without the [illegible] of the reflectors which [illegible] with [illegible] lamps.

[illegible] can be [illegible] transformers with their secondary circuits connected as a △ or as a Y Although the construction of a regulator with two rotary fields presents no serious difficulty Righi employs a simple hand regulator

If three intermediate arcs are formed among the three lower carbons with the central carbon raised high and the central carbon is then lowered until three arcs are formed between it and the lower carbons, no great variation in the emission of light or the consumption of energy is observed during the movement As soon as the three craters of the central carbon have been formed, however the consumption of energy is usually diminished and the light hitherto flickering and poorly distributed becomes steady and is greatly intensified and distributed more effectively

The central carbon is consumed very slowly and in certain conditions its craters are replaced by excessively bright protuberances which point toward the lower carbons

The Mercanton triphase lamp can be operated with a frequency as low as 17 alternations per second owing to the close approximation of its three craters and the fact that at least two arcs are always active As the Righi lamp has six craters and produces a still greater concentration of heat, it can probably be operated with still lower frequencies The importance of this point becomes evident when we recall that the minimum frequency that can be used with a motionless lamp is about 26, and that most triphase traction systems have a frequency of 15

No very certain results have yet been obtained from attempts to operate the Righi lamps with the low frequency rotor currents of an asynchronous triphase motor as the frequency varies with the load and it is very difficult to keep it constant but the inventor intends to resume the experiments as soon as more favorable conditions can be established —Revue des Sciences

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The following note appears in a consular report for the year 1909 on the foreign trade of China In view of the almost limitless possibilities which seem to exist in China especially in the great plains of the north for the use of agricultural machinery it is with reluctance that one has to record the opinion that under present conditions there is really no opening for its successful introduction The financial risk attending the purchase of such machinery for the Chinese has been proved in several instances and British firms in China have to be careful how they repeat similar experiments Certainly British manufacturers desirous of introducing agricultural machinery into China would have to be prepared to share the risk with their agents to a much greater extent than they show any signs of doing at present But the subdivision of farms among small peasant proprietors who are extremely conservative in their methods the cheapness of human labor and the absence of effective organization of agriculture on the part of the Chinese government are among the conditions that discourage manufacturers from taking risks that experience has not justified"

The Paris Automobile Show*

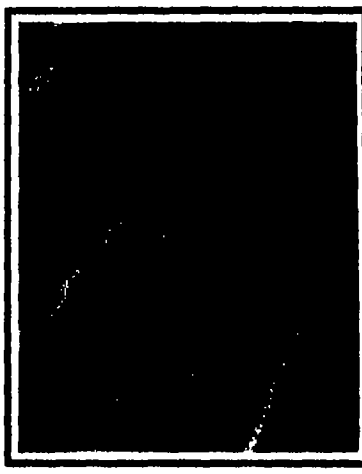
The First Exhibition Held by the Manufacturers Themselves

Shorn of some of its former glory and inaugurated under a new management the Paris Salon of 1910 which closed on the 18th instant was altogether a different Salon from the last which was held two years ago Nothing of the sort held in Paris could in the nature of things be anything but spectacular and the present show is striking and in many respects characteristic But the uniform system of decoration adopted had the effect of breaking up the vista of the Grand Palais and in itself was more or less con fusing

The show itself was lacking in one of the features that in he past has rendered it the show of shows. In common with all shows of the day but to a more notable degree it lacked the element of extreme nov elty not to say freakishness in cars bodies and accessories The rare imagination of the French was of Knight, yet each of them has peculiarities all its own For example in the Roland Pilain but one sliding sleeve is employed instead of two as in the Knight engine the motor otherwise resembling the Knight in many respects Incidentally it may be mentioned that the Roland Pilain car in which was mounted a six-cylinder motor of the type in question was further distinguished by an equipment of hydrau lic brakes which were applied to all four road wheels.

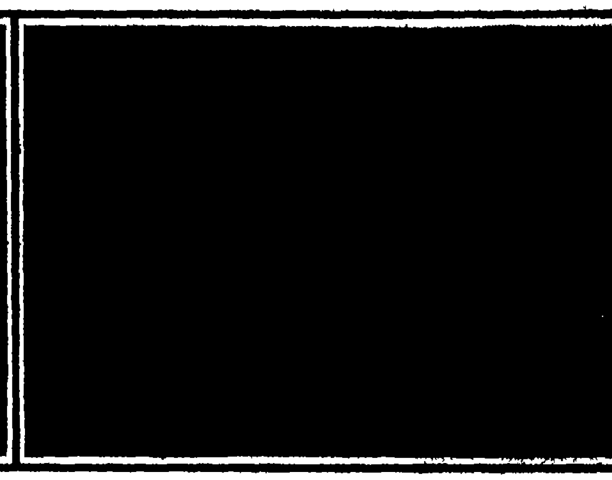
In the case of the motor shown by Mustad et Fils the valve construction was equivalent to a single sleeve split in half vertically Each half sleeve carrying a suitable port opening as in the Knight engine is actuated independently from one of two eccentric shafts In the new Cottereau motor a single sleeve likewise is deemed sufficient but instead of being made to travel up and down the cylinder bore as is the proper instant of the cycle. Unlike the Corliss valve however it does not oscillate, but revolves. Hence by placing one of the passages above and the other below the valve chamber the single member is made to serve both the inlet and the exhaust. A com mendable point in the design is that the port is placed somewhat below the upper end of the piston travel in the cylinder so that the valve is relieved of excessive pressure during the beginning of the firing stroke

The Boissier motor likewise is furnished with a form of rotary valve termed a distributor in this instance, which is mounted above the cylinders and which as it is carried in ball bearings offers very little frictional resistance Owing to the relatively large size of the distributor and its casing the motor is given a curious and rather top-heavy appearance, which is not in the least relieved by the vertical mo-

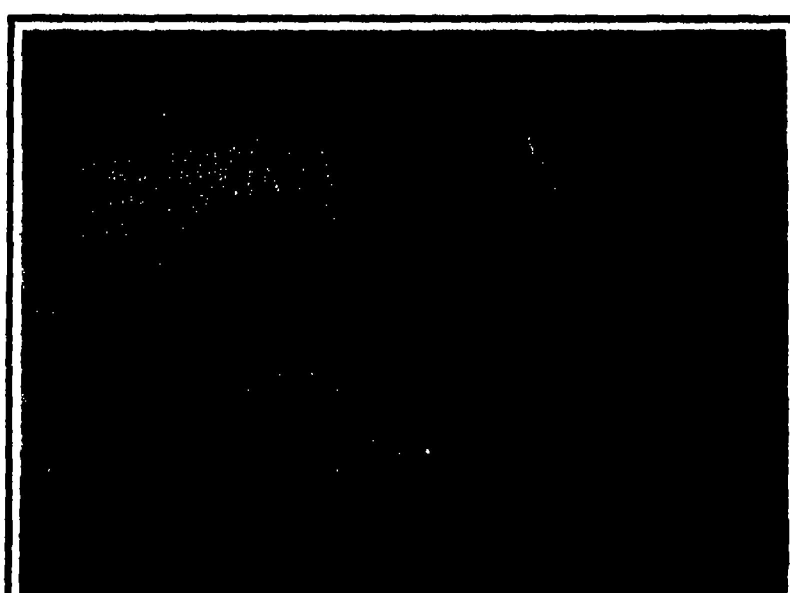


CUT-AWAY REAR AXLE AND DRIVE SHAFT SH WING BEVE J INT OF THE SIZAIRE AND NA I IN AR

THE 120 HORSE POWER PIPE CAR WITH INCLINED WIND BREAK WHICH SHIELDS THE CHAUFFEUR AND C TS DOWN WIND RESISTANCE



DETAIL OF BRAKE DRUM AND CARDAN JOINT OF THE RENA IT CAR



GOBRON CAR, WITH FOLDING SEAT

FOUR CYLINDER 24 HORSE P WER GREGOIRE MOTOR, WITH GLASS DASH

THE PARIS AUTOMOBILE SHOW

apparent in many instances it is true but not to its former extent. For the most part the exhibits were rather conventional in their nature and sweeping trends were lacking There were 350 stands or less, 125 of which were occupied by exhibitors of cars The accessory and components exhibits which composed the remainder for the most part were those of the established manufacturers and dealers who showed more or less standard wares. But two American makes of cars were in evidence namely the Mitchell and the Ford

If the show may be said to have developed anything in the way of mechanical tendency it is in the so-called "valveless motor—which is not a valveless motor at all but one having either sliding or rotary valves instead of those of the common or poppet type. There were practically a dozen different motors of this class to be seen including one or two that were shown in the balconies and also including the Panhard Mercedes and English Daimler cars which are equipped with variations of the Knight engine

Several of the engines which fall within the valveless classification appear to have been designed by followers done in the case of the valve systems previous y men tioned the valve sleeve is merely caused to revolve in a suitable recess which is formed in the cylinder wall The single port opening in its surface thus is made to register alternately with the inlet and exhaust open ings The Sizaire et Naudin formerly distinguished as a light voiturette with a huge single-cylinder motor now is built in the form of a light and more conven tional machine and is equipped with a motor of the 'valveless' type

Among the engines which reveal more radical departures from precedent, perhaps none attracted more attention than the Henriod partly it is to be inferred for the reason that its constructor in the past has distinguished himself by several unfettered flights of fancy in the way of novel design In this case how ever there is nothing irrational about his achievement, which is, nevertheless distinctly radical. It is, in brief a form of rotary valve which is broadly suggestive of the Corliss steam engine gear That is to say the valve itself is a D-section, though revolving in circular bearings, the flat side of the "D" serving to uncover the single port in the cylinder wall and to open communication with the intake or exhaust at tion shaft and the housing for the helical gears by which the distributor is actuated Still another motor of the rotary valve type is the Ballo in which the valves are of hemispherical formation and oscillate instead of rotating Their movement is brought about by cam action the valve motion shaft and cams being inclosed in a housing above the cylinders, which is of peculiar and characteristic shape.

By all odds the most original, not to say freakish, design to be found was that of the Broc motor in which the effects of a sliding valve and a rotary valve are achieved after a most curious fashion. The distribution is effected by the simple expedient of converting the piston itself into a valve and causing a portion of it to revolve in the cylinder in addition to its reciprocating motion. A helical groove is formed in the outer part which leads from the base to a point just below the head, where a hole is cored through to a couple of ports in the head proper. The intake and exhaust ports, of course, are located in the lower part of the cylinder.

As a matter of fact, the piston is [illegible]

*Reprinted from the Motor World.

wrist pin and connecting rod, and does the work of driving. The secondary part is a surrounding sleeve, in which the helical groove is formed, and which is rotated by means of a bevel gear on the lower end of a tubular shaft which telescopes the connecting rod and is driven by a stationary bevel gear attached to one of the crank webs. As the piston reciprocates the outer or valve portion is reciprocated with it and also is rotated to effect the distribution. Thus the motor is valveless only so long as the outer portion of the piston is by courtesy considered a part of this piston and not a valve

Among other points observed at the show was the apparently growing inclination of the French builders as well as those of other Continental countries, to construct cars well within what is broadly termed the medium-powered class Particularly noteworthy at this time indeed are the numerous cars of 16 to 30 horse-power nominal rating and especially those of somewhere about 20 horse-power The block method of casting continues to grow in popularity and not a few six-cylinder motors of relatively low power now are made in this fashion Among such may be enum

Another observation was the periodical decline of the voiturette which again appears to be passing into obscurity after a season of renewed popularity The bulk of the European trade appears to be in cars of the medium class all through and though closed cars continue to gain in popularity the favorite styles are those in which the entire vehicle is inclosed whether they afford accommodation for two or more passengers The torpedo styles of touring car and runabout have come into vogue and the influence of the torpedo is seen in many forms of closed cars

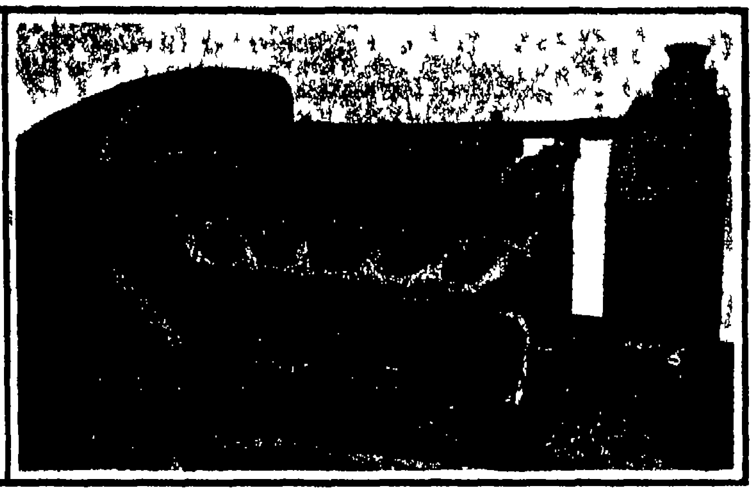
A remarkable instance in point is that of a Gregoire car which is built on thoroughly approved marine lines, with a ridiculously small body superstructure mounted in the center in close semblance to the conning tower of a submarine Another remarkable achievement of the body maker s art is the 120 horse-power Pipe the front of which slopes from a point immediately above the driver s head to the dash thus giving the machine the appearance of having just come through some dire catastrophe in which its front portion had been sadly crushed A body which is far more appealing if somewhat less striking in its

hood after a fashion introduced by at least one maker in this country last year separate spring suspension for the radiator and brass covers for the joints in the steering connections are novel and interesting details that were to be observed on various cars

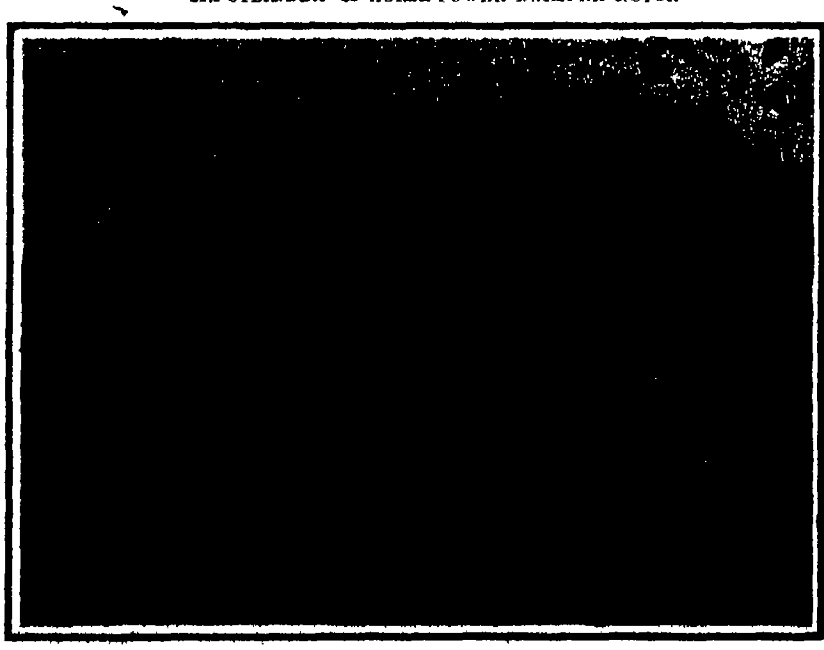
The general details of transmission and other chassis features reveal few striking changes in the new designs Universal joint construction in many instances has been revised with the idea of obtaining better durability and freedom from wear and in this connection the Isotta Frashchini universal is particularly noteworthy It consists of nothing more complicated than a disk of stiff leather which forms the sole connection between the flanges of the driv ng and driven members of the joint Besides allowing perfe t flexibility and small resistance this device has the advantage of being abso utely noiseless

The new type universals on the lates Rens it designs are housed in a neat alumini m asing The rear springs of the new hassis shown t h Salo are of the three-quarter elliptical pattern b t with the lower or semi-elliptical members slu g beneath the axle thus affording a very low center of gravity

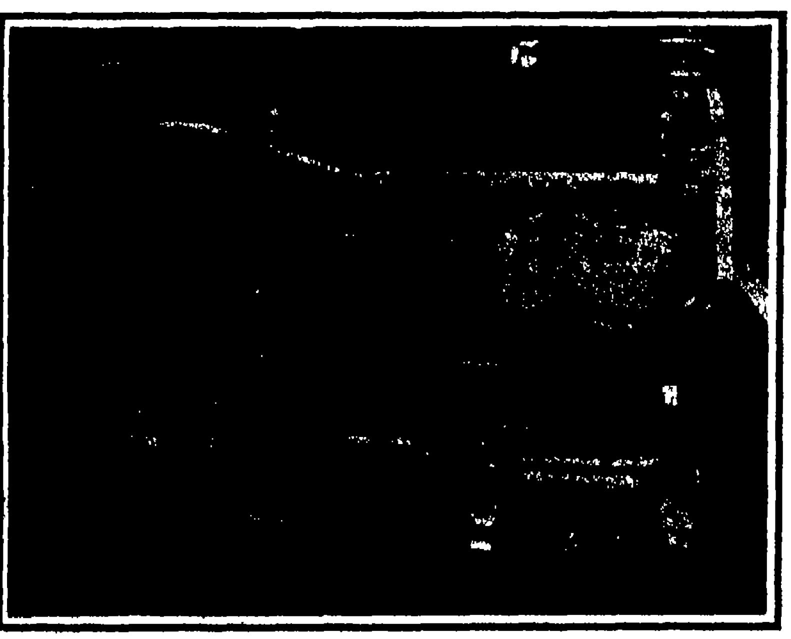
SIX CYLINDER 25 HORSE POWER DAIMLER MOTOR



SIX CYLINDER 90 H RSE POWER PIPE M T R



THE FIAT LIMOUSINE WITH TORPEDO SHAPED BODY



THE BENZ MOTOR FOUR CYLINDER 40 HORSE POWE

THE PARIS AUTOMOBILE SHOW

erated the Delage which is rated at 16 horse-power and has a bore and stroke of 66 by 12 millimeters or roughly 2⅝ by 5 inches and the Delahaye which is rated at 18 to 24 horse power and has its cylinders arranged in V form in two groups of three but all cast together the cylinder dimensions being 75 by 120 millimeters, or 3 by 4 13/16 inches Other small six-cylinder motors but those in which the cylinders are cast in pairs or in blocks of three are the 17 to 20 Mors 16 Motobloc, 20 horse-power Darracq—a worm-driven model it may be explained—15 horse-power Clement Bayard and 12 horse-power Delaunay Belleville the last has cylinder dimensions of 72 by 120 millimeters or about 2⅞ by 4 13/16 inches

Two marked effects of the new style construction which is expressed in the popular form of block motor also are beginning to be apparent in other types as well. One is the desire to secure a clean" engine by stowing away the auxiliaries as neatly as possible and relieving the exterior of the cylinders of any needless encumbrance. The other is to extend the stroke. [illegible] abnormally long strokes by no means are the [illegible] also by no means uncommon, while the [illegible] seems to be to increase the bore-to-[illegible]

appearance is the Fiat obus which is a Rothschild creation and which besides being of the most sumptuous order is built with an eye to cleanliness and freedom from unnecessary windage

The Gregoire aviator body is strictly a double coach and has much the same effect as would be secured by mounting two sedan or coupe bodies on the same chassis Needless to add it is of the two-compartment type as distinguished from many of the newer bodies in which there is but a single door on either side and no dividing partition between the front and back seat spaces

Among various individual body refinements may be mentioned one particular runabout body mounted on a Gobron chassis, which is provided with a deep scuttle dash Under ordinary circumstances there is nothing to indicate that the dash is in any way extraordinary But when it is desired to carry a chauffeur one side of the scuttle may be removed disclosing a neat folding side seat into which a small or medium-sized chauffeur may be squeezed without serious inconvenience and where he will be handy in case a tire goes down or the engine becomes obdurate

Ventilated dashes for the inclosed torpedo bodies electric lights built into the dash or the front of the

Three-quarter ellip ic s spensions by the way are growing in popularity

Shaft drive is employed almost exclusively as is magneto ignition Thermo syphon cooling likewise is becoming exceedingly popular while automatic self contained engine oiling systems are the rule

In addition to the Sizaire et Naudin change gear which is of unique construction and mounted on the rear axle one other peculiar axle mounted change gear was in evidence—that of the Miolans car in which the speed changes are effected by ca sing a single driving pinion to mesh with one or another of three sets of teeth on the large driven gear the teeth naturally being of peculiar formation in order to render this combination possible But one friction drive was in evidence that of the Ouricum which employs the two-disk principle

Dentists Modeling Wax —Twenty five parts of pale gum copal are melted in the sand bath and when half cooled 25 parts of stearine are stirred into it and dissolved Then stir in 50 parts of Venetian chalk and 0.5 part of carmine perfuming it with 2 drops of oil of roses

The Development of Submarine Boats*

From Bushnell to Holland and Lake

By Simon Lake

When the United States government in 1893 advertised for inventors to submit designs for the construction of a submarine torpedo boat it is doubtful if a corporal's guard of officers in the United States service could have been found that had any faith in this type of vessel

The submarine boat at that time was considered as great a curiosity by the majority of people as the flying machine was previous to the public flights of the Wright brothers a little more than a year ago At that time neither the United States England Russia nor any of the European countries were in possession of what might be termed a practical submarine vessel

The French government had one experimental vessel in commission called the Gymnote and another under construction which was called the Gustave Zede The latter was launched in June 1903 Both these vessels were of the diving type and operated on the same principle as numerous others that had been experimented with during the nineteenth century

The records show that nearly a hundred submarine boats have been projected or built to operate on practically the same principle as the Gymnote most of them vessels of small size Drzwiecki the inventor of the torpedo firing apparatus which bears his name built a large number of small vessels of this type for the Russian government in the seventies They were one-man boats

Several boats were built by the Confederates during the Civil War which operated on the same principle The attempts to use these vessels however usually resulted disastrously the boat having a tendency to dive head first to the bottom in some cases remaining there permanently especially if the bottom was soft If the bottom was hard and the hull was sufficiently strong to withstand the shock the vessel would rebound to the surface

Hovgaard in his book on submarine navigation refers to one of the early French boats of the diving type called Le Plongeur This boat was the most ambitious attempt to construct a submarine vessel during the nineteenth century She was about 140 feet long 20 feet broad and 10 feet deep Her beam was therefore twice her depth She had an oval form in cross section and was presumably braced to resist the pressure of water when submerged This form of hull would need to have been strongly braced to resist collapse at any considerable depth as her plate was said to be only ½ inch near the keel and ⅜ inch throughout the rest of the vessel She was propelled by a compressed air engine which developed 80 horse power when working with air at twelve atmospheres It is stated that the engine always worked well Her displacement was about 200 tons In his description of this vessel Hovgaard says

The greatest difficulty was the regulation of the motion in a vertical sense Operations commenced by closing all openings and then water was let into the two air reservoirs and into the water-tight compartments until only the top of the conning tower was above the surface It was found to be pretty easy to go like this awash along the surface of the sea It was expected that the depth of immersion could be determined by small changes in displacement namely by using the piston in the regulating cylinder but the experiment showed this to be quite impossible and the vessel would often touch bottom even in 30 feet depths before the motion could be changed When striking tolerably hard bottom such as sand the vessel would rebound like an India rubber ball Thus the 'Le Plongeur' would advance striking alternately the bottom and remounting to the surface

The horizontal rudders and the regulating cylinders acted much too slowly Most frequently they had to resort to the donkey pump or to air pressure to expel water but then the ascension would take place very violently and when at the surface, the vessel would be found to have a buoyancy of several cubic meters A vertical screw was therefore fitted to regulate the motion up and down It was worked by hand In this way the equilibrium under water was kept, but only for a very short time

The result of the experiment was that it was possible to make a submarine boat slide along the bottom in the way described above and also to move steadily awash.

It will be seen from the above description, and the abandonment of the vessel that this boat, like many others of the type was unmanageable when attempts were made to run her in a submerged condition With her shallow depth and great beam it is probable that the failure of this vessel was largely due to a lack of longitudinal stability which stability in my estimation is the first and most important thing in the designing of a suitable vessel.

The Confederates attempted to use the submarine boat during the Civil War and succeeded in sinking one of the United States warships They called the little submarine boats which they constructed at that time Davids and the name was a most apt one The next war will probably prove that the submarine Davids will be able like David of biblical fame to destroy the great Dreadnaughts or Goliaths, of the present day

Previous to the beginning of the nineteenth century some experiments had been made in the construction of submarine vessels. The first important one of which there is any record was constructed in the seventeenth century by Cornelius Debrell a Dutch man who lived in England during the reign of James I Nearly a hundred years later a man by the name of Day built a submarine and made a wager that he could descend to a depth of 100 yards and remain there twenty four hours He did, and according to latest advices is still there

The most authentic information at hand however regarding the early submarines is of a boat built by a Connecticut man Dr David Bushnell who lived in Saybrook during the Revolutionary War He built a small submarine vessel called the "American Turtle with which he expected to destroy the British fleet anchored off New York during its occupation by General Washington and the Continental Army

Thatcher's Military Journal" gives an account of an attempt to sink a British frigate the Eagle of 64 guns by attaching a torpedo to the bottom of the ship by means of a screw manipulated from the interior of this submarine boat A sergeant who operated the Turtle succeeded in getting under the British vessel but the screw which was to hold the torpedo in place came in contact with an iron strap refused to enter and the implement of destruction floated down stream where its clockwork mechanism finally caused it to explode throwing a column of water high in the air and creating consternation among the shipping in the harbor Skippers were so badly frightened that they slipped their cables and went down to Sandy Hook General Washington complimented Dr Bushnell on having so nearly accomplished the destruction of the frigate

If the performance of Bushnell's "Turtle was such as described it seems strange that our new government did not immediately take up his ideas and make an appropriation for further experiments in the same line When the attack was made on the Eagle Dr Bushnell's brother who was to have manned the craft was sick, and a sergeant who undertook the task was not sufficiently acquainted with the operation to succeed in attaching the torpedo to the bottom of the frigate. Had he succeeded, the "Eagle" would undoubtedly have been destroyed and the event would have added the name of another hero to history and might have changed the entire method of naval warfare Instead of Bushnell being encouraged in his plans however they were bitterly opposed by the naval authorities His treatment was such as finally to compel him to leave the country but he returned after some years of wandering and under an assumed name settled in Georgia, where he spent his remaining days practising his profession.

Robert Fulton the man whose genius made steam navigation a success was the next to turn his attention to submarine boats and submarine warfare by submerged mines A large part of his life was devoted to the solution of his problem He went to France with his project and interested Napoleon Bonaparte who became his patron and who was the means of securing sufficient funds to build a boat which was called the 'Nautilus." With this vessel Fulton made numerous descents, and it is reported that he covered 500 yards in a submerged run of seven minutes

In the spring of 1801 he took the "Nautilus" to Brest and experimented with her for some time. He and three companions descended in the harbor to a depth of 25 feet and remained one hour, but he found the hull would not stand the pressure of a greater depth. They were in total darkness during the whole time, but afterward he fitted his craft with a glass window 1½ inches in diameter, through which he could see to count the minutes on his watch. [illegible] discovered during his trials that the [illegible] pass pointed equally as true under water as [illegible]

His experiments led him to believe that he could build a submarine vessel with which he could swim under the surface and destroy any man-of war afloat. When he came before the French Admiralty however, he was met with blunt refusal, one bluff old French admiral saying 'Thank God France still fights her battles on the surface, not beneath it, a sentiment which apparently has changed since those days as France now has a large fleet of submarines. After several years of unsuccessful efforts in France to get his plans adopted, Fulton finally went over to England and interested William Pitt, then chancellor, in his schemes He built a boat there, and succeeded in attaching a torpedo beneath a condemned brig provided for the purpose blowing her up in the presence of an immense throng Pitt induced Fulton to sell his boat to the English government and not bring it to the attention of any other nation, thus recognizing the fact that if this type of vessel should be made entirely successful, England would lose her supremacy as the Mistress of the Seas'

Fulton consented to do so but would not pledge himself regarding his own country stating that if his country should become engaged in war no pledge could be given that would prevent him from offering his services in any way which would be for its benefit.

The English government paid him $75 000 for this concession Fulton then returned to New York and built the Clermont' and other steamboats but did not entirely give up his ideas of submarine navigation and at the time of his death was at work on plans for a much larger boat.

Fulton had a true conception of the result of submarine warfare and in a letter he says Gunpowder has within the last three hundred years totally changed the art of war and all my reflections have led me to believe that this application of it will in a few years put a stop to maritime wars give that liberty on the seas which has been long and anxiously desired by every good man and secure to Americans that liberty of commerce tranquillity and independence which will enable citizens to apply their mental and corporeal faculties to useful and humane pursuits to the improvement of our country and the happiness of the whole people

After Fulton's death spasmodic attempts were made by various inventors looking to the solving of the difficult problem but no very serious efforts were put forth until the period of the Civil War and then a number of submarine boats were built by the Confederates These boats, as already referred to were commonly called 'Davids and it was one of them that sank the United States steamship Housatonic in Charleston Harbor on the night of the 17th of February 1864 This submarine vessel drowned four different crews a total of thirty men during her brief career At the time she sank the Housatonic" her attack was anticipated and sharp lookout was kept at all times but notwithstanding their vigilance she succeeded in getting sufficiently close to plant a torpedo on the end of a spar and sink this fine, new ship of 1 400 tons displacement.

According to one of the officers of the 'Housatonic ' the attack was made in the following manner "About 8 45 P M the officer of the deck, Acting Master M K. Crosby discovered something in the water about a hundred yards away coming directly toward the ship, the time from its appearance until it was close alongside being about two minutes, during which time the chain was slipped, engine backed, and all hands called to quarters. The torpedo struck the ship forward of the mizzen mast on the starboard side, in line with the magazine, and as we had the after pivot gun pivoted to port, we were unable to bring a shot to bear upon her About one minute later she was close alongside and the explosion took place the ship sinking stern first, and heeling to port as she sank. Most of the crew saved themselves by going into the rigging while a boat was dispatched to the 'Canandaigua.' The vessel came gallantly to our assistance and succeeded in rescuing all but a few of the officers. What became of the 'submarine boat' was a mystery not solved until a few years ago, when some divers in searching about the wreck of the sunken steamship found, a few feet away from her, the 'David' with skeletons of her crew still abroad. It was found that the hatch was open, and it is supposed that the water thrown up by the torpedo caused her to founder with all hands."

It will be observed by the above [illegible] [illegible]

* Proceedings of the Engineers Club of Philadelphia.

to maneuver the boat sufficiently near the "Housatonic" to prevent discovery until too late to ward off the attack.

The author was fortunate enough several years ago to receive a visit from Mr Charles H Hasker of Richmond, Va. formerly lieutenant of the Confederate ironclad "Chicora," stationed in Charleston Harbor While experiments were being made with the submarine vessel just described Mr Hasker volunteered as one of the crew for the experimental trip about the river, and was one of four that escaped when the vessel went down He gave me the following account of her sinking

"The submarine had a line fast to the steamer Etawan off Fort Johnson the crew were all in their places, and had started the craft ahead The buoyancy of the vessel had been reduced so that only the hatch combings were above the water The side submerging vanes were operated by a tiller connected with the athwartship shaft, and were held in a horizontal position by means of a stick of wood placed beneath When the vessel started ahead Lieut. Paine attempted to cast off the line which was made fast around the hatch combing He became entangled in the line causing the boat to sheer slightly and careening her sufficiently to permit the water to come in the forward hatch. The lieutenant in his struggles to extricate himself, struck the prop which supported the ends of the tiller thus causing it to drop to the floor and forcing the forward ends of the vane downward This of course immediately pulled the bow of the boat under water Mr Hasker occupied the forward seat just at the hatchway Lieut Paine succeeded in getting out as soon as he saw the boat was going to sink and Mr Hasker grasped the edges of the hatch combing and finally forced his way through the column of inrushing water which was by this time coming in with great force But before he was entirely out of the opening the pressure of the water closed the hatch door which caught his left leg below the knee The pressure of the water was so great against the door that it crushed the muscles of the leg and held him in this position until the vessel had reached the bottom in seven fathoms of water The hull then being filled with water equalized the pressure so that he was able to lift the door and being an expert swimmer he swam to the surface The boat went down head first and before the after hatch got under water two other men succeeded in escaping the other five being drowned

Notwithstanding that this was the third time the boat was sunk she was again raised and a new crew was found to man her Mr Hasker states that he was unfortunate enough to be captured at the evacuation of Morris Island about one week after this occurrence was kept prisoner for fourteen months and was at Hilton Head prison when he heard that the submarine had finally accomplished her mission in sinking the U S S Housatonic

This brings us to 1893 and to the more recent attempts to solve the problem of submarine navigation which at the present day is an accomplished fact and every nation of importance is adding submarine torpedo boats to its fleet for purposes of defense and many of them are even now proposing vessels for offensive as well as defensive purposes

In 1877 Mr John P Holland built a small boat which was called the Fenian Ram It is stated that this vessel was built by capital furnished by the Clan na Gaël with the idea of using it against the British fleet in an attempt to free Ireland It is reported that Mr Holland who was a school teacher had been exiled from that country because of his political activity From the published description of this boat it would appear to be very similar to the small boat turned out by Drzwiecki for the Russian government in that it operated with a vertical and a horizontal rudder in the same manner as other boats of the diving type which have been mentioned

Previous to the appropriations made in 1893 Mr Holland had built several small boats of this type and it is reported that he met with considerable success in navigating them

Mr Baker of Chicago had built a vessel of quite a different type. His boat was elliptical in shape and in form resembled the "Goubet' type of vessel It was propelled by screws located about midship on either side of the vessel These screws were operated by gear wheels in such a manner that the angle of thrust could be changed to submerge the boat, the vessel having a certain reserve of buoyancy, the propellers could be set at such an angle as to cause the vessel to submerge until she reached a given depth and then, by slightly reducing the angle, the vessel would move forward theoretically on a straight course and on a line which would be a mean between the upward pull due to the buoyancy of the vessel and the downward and forward pull due to the inclination of the propellers

It is reported that this vessel made a number of successful trials in the waters of Lake Michigan The form adopted by Baker was one well adapted for giving great stability but was not suited to speed It was largely due to Baker's success however and to the report made by a board of officers which watched the performances of this craft in 1892 that the first appropriation of $200 000 was made for the construction of the United States submarine When the appropriation was made Baker was so sure of receiving the award for the contract that he moved from Chicago to Washington with the idea of being close to the government authorities while developing the plans for his large vessel He died shortly after moving there Mr Holland Mr Baker and the author it is believed were the only inventors of submarine craft that were present with plans in Washington at the opening of bids in June 1893 The author did not submit a proposition to build a vessel as the advertisement stated that the department would consider designs even if they were not accompanied by tenders for construction and if the designs were considered meritorious the department would itself arrange for the construction of the vessel The author's designs were submitted to a board to pass upon their merits and he was later advised by the late Admiral Matthews that his designs were looked upon with considerable favor by some of the members of the board at that time but as the Holland designs were accompanied by a bid to construct with a bond for performance backed by a company the Navy Department was reluctant to take upon itself the responsibility of the development of a vessel from designs only The matter of awarding a contract was held in abeyance for over a year and finally the award was made to the Holland Company for the construction of the Plunger on certain guarantees of performance which guarantees were destined never to be fulfilled under the first contract as this boat the Plunger was to have done many things that even to this day have never been accomplished by any submarine boat She was to have a speed of about 16 knots and be able to go from light condition to that of complete submergence in twenty seconds Her construction extended over a period of several years and she was finally abandoned in 1900 after the Holland Company had received additional appropriations and brought out a much simpler vessel in the Holland the first United States submarine torpedo boat which went into commission

The first Lake design was of a submarine boat previously referred to and was submitted to the United States Government in 1893 in response to a public advertisement asking inventors to submit bids for submarine boats for the United States Government

Some of the features of this design were two hydroplanes on either side at the bow and the stern with fore-and-aft rudders for correcting trim There were wheels for navigating on the bottom This boat was fitted with four torpedo tubes two forward and two aft

The Holland was the first United States submarine boat and is the boat previously referred to which took the place of the Plunger the first United States boat contracted for This type of boat operates in the same manner as the early French and Spanish boats It also operates on the same principle as the Whitehead torpedo except that the intelligent control of man operates the vertical and horizontal rudders rather than automatic appliances The principle of operation however is the same

These boats are still built in the cigar-shaped form which is without doubt the best form for under water speed but has certain disadvantages as a surface sea going craft, and is more difficult to control when operating submerged The earlier boats of the Holland type were lacking in stability and were very erratic as to their performance having a tendency as did the early boats of the same type constructed in France and Spain and as did the boats of similar type before referred to that were constructed during the Civil War either to run their nose into the bottom or to broach to the surface

These vessels have been much improved however in the last three or four years owing to the greater experience in their design and construction and the necessity now—since competition has been permitted in the securing of submarine vessels for the United States navy—of providing vessels that will meet the requirements of the United States naval authorities The standard of performance now required by the United States navy is the most severe of any country

Early in 1901 the author received a request to come to Washington and submit designs to the navy department for the construction of submarine torpedo boats of the Lake type as the department was not satisfied with the performance of its Holland type of submarine then The designs of the Protector and of the cruiser type of boat were submitted to the Board on Naval Construction at that time composed of five admirals and the author was informed that his designs were considered superior to anything yet proposed in the way of submarine boats either in this country or abroad Congress had always specified Holland boats notwithstanding the protest of many officers in the navy department It was suggested however that if a submarine boat were constructed with private resources it was within the power of the navy department to see that such a vessel would be given a fair trial when completed and that the department could make such recommendations as were impossible for Congress to ignore On the strength of these promises the author started to construct the Protector

The later German Krupp boats are fitted with the buoyant superstructure and hydroplanes The latest boats are fitted with omniscopes

One of the features of the Lake type of boat has been that it carries its fuel outside of the living quarters of the crew in especially designed tanks in the superstructure which tanks are galvanized to prevent the escape of dangerous fluids or gases Both the German boats and the Italian boats have adopted this feature the only difference being that the fuel tanks were built up directly over the hull of the vessel rather than being built circular in form and galvanized after construction It appears that the fuel leaked through this built up tank in the Italian boat Foca down into the hull where it became ignited and caused an explosion which blew up the vessel and killed her crew of twenty three men This was probably due to some careless workmanship or neglect on the part of some members of the crew to take proper precautions in seeing that the pipe connections where they came through the hull were properly made It is impossible to provide against the ignorance and carelessness of workmen and members of the crew Many explosions have occurred both in this country and abroad on submarine boats and numerous lives have been sacrificed which with a little more thought and care might have been saved

There are a number of dangerous things in connection with submarine boats The gas which is given off in large quantities from the batteries is hydrogen and is very explosive If the fumes of the gas are not pumped out as rapidly as they are given off an explosion is very likely to occur The fumes of gasoline when mixed with the proper proportion of air are also highly explosive For this reason Lake boats always carry fuel outside of the main hull and fortunately so far no lives have been lost on any of these boats although a number of men were nearly lost last August on the Russian submarine Dragon This was before the boat was entirely completed and was caused by the carelessness of one of the workmen in pouring several gallons of gasoline into the hull through an open pipe before the same was connected up The accident resulted in severe injuries to a number of the men and about $100 000 damage to the boat

The dangers of gasoline have brought about extensive experiments in trying to develop heavy oil engines for submarine boat service Hundreds of thousands of dollars have been expended in trying to produce a satisfactory engine of this class All governments are now calling for heavy oil engines and if experiments now well advanced prove their practic ability it will bring about a revolution in the construction of internal combustion engines not only for submarines but for all other classes of boats using liquid fuel

Two of the Lake boats, 161 feet long are under construction for the United States Government at Newport News One is the Seal the other is the Tuna. The Seal is the largest and most powerful submarine boat now under construction for the United States Government

(To be concluded)

During the year 1909 electric lighting contracts were given out for new installations at Chungking, [illegible], Nanking, and Ningpo, and for more or less important extensions at Shanghai (settlements and native city), Hankow, Peking, Swatow, [illegible] and other places. Negotiations were going [illegible] a large installation at [illegible] several cities in Manchuria. Indeed, there may be said to be an electric lighting project in every city in China although at Pakhoi the project is stated to have been abandoned in view of the successful introduction of incandescent mantles the only difficulty is to find funds for carrying such projects into execution Almost all contracts require to be financed by the contractors and British firms, finding British manufacturers unwilling to supply plant except for cash down have sometimes co-operated with German firms the latter arranging the finance in return for being allowed to participate Thus several of the contracts mentioned above are for British engines and boilers and German dynamos Payment is generally spread over a period of two or three years on proper security being given to the contractors

Jarman's System of Electric Traction by Storage Batteries

A Pioneer Electric Tramcar

The subject of electric traction by means of stored energy having come to the fore again because of the improved form of storage battery by Mr Thomas Edison the following historical account of a storage battery system of electric traction that proved to be a thoroughly practical one from every test that could be made either from an electrical or engineering standpoint as well as from a constructional view can but prove of value to many who are concerned with electric traction to-day

It was on October 25th 1886 that Mr A J Jarman invited a large number of editors and proprietors of the daily and technical press to witness the practical working of a model electrically propelled car at No 443 Brixton Road London England This model was fitted upon trestles at the back of the premises A considerable number attended and saw for the first time an electrically propelled vehicle

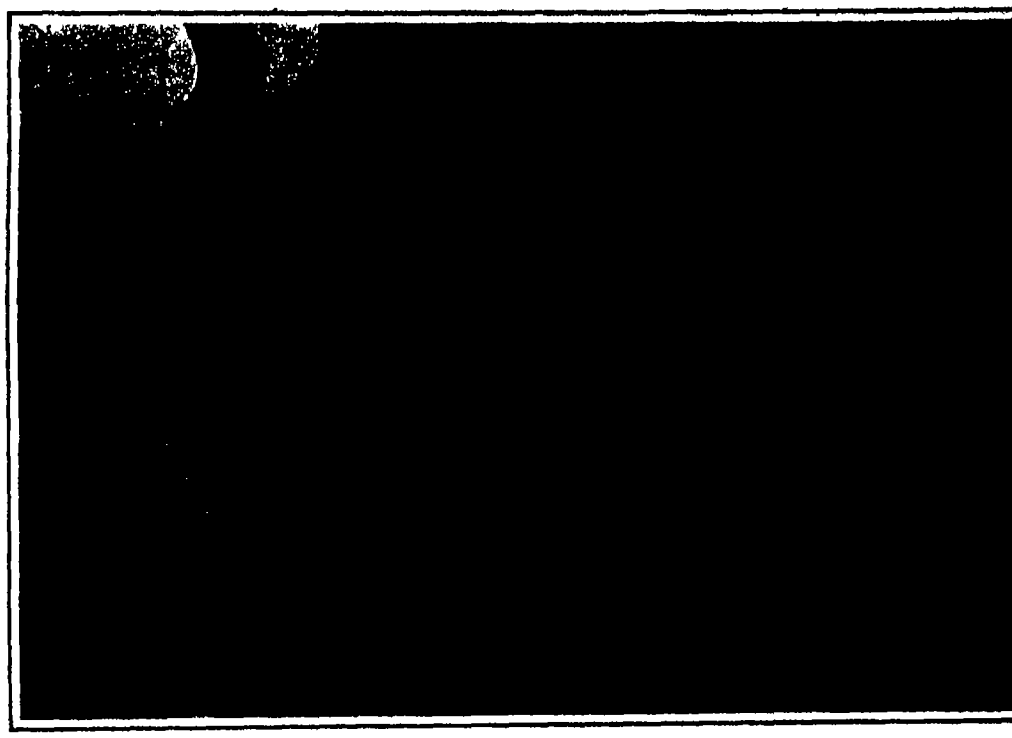
This model was 3 feet 7 inches long was driven with a double armature motor and thirty carbon zinc cells placed beneath the seats The car travelled at a speed of over five miles per hour The tests lasted from 11 o'clock A M until 3 30 P M satisfying every suggestion made by the representatives of the press One of the photographs shows the model and trestle tramway Another photograph shows the experimental passenger car that was made from a disused horse car of the London Tramways Company The car body alone weighed three (British) tons equal to 6 7 0 pounds the electrical equipment being in addition

The inventor designed built and fitted a motor to this car with a double armature which when completed was put on test by permission of the London Tramways Company after 12 midnight when the horse cars ceased running The trial took place in March 1887 and the car ran from Atlantic Road Brixton to Westminster Bridge and returned successfully in every particular carrying 45 passengers At the end of the journey this car was driven over the macadamized Atlantic Road from Brixton Road to Electric Lane without rails by its own power In November of the same year the car was deposited at the disused stables of the London Tramways Company at Clapham Cross where another trial took place The car was driven from Clapham Cross to Blackfriars Bridge and return (This was the first electrically driven car that ran to the above bridges of the city of London Upon another occasion this car carried 115 passengers from Westminster Bridge to Clapham Cross

The third photograph illustrates the car that was the outcome of every suggestion and improvement that the experimental car indicated Fitted with reversible top seats although constructed with seats for 44 passengers it carried upon many occasions as high as 86 passengers

This car was fitted with a compound bipolar motor of 14 horse power and compound gearing together with ampere meters and voltmeters at both ends of the car so as to enable the observer to note the actual electrical horse power used either upon a level or a variable incline The construction of the motor differed materially from any hitherto attempted The whole of the desired resistance was constructed within the windings of the field magnets no external resistance being used whatever The result was that only the necessary amount of electrical energy was employed to start the load without loss in a wasteful external resistance By this plan the car could never start with a sudden jerk

The following tests were made that proved the value of this part of the invention It may be mentioned here that the controller was so constructed that the forward and backward motion of the car was made by turning the handle to the right in four steps for forward and to the left for backward motion no extra controller being used as is the case upon many cars to day



MODEL OF ELECTRIC CAR ON THE TRESTLE TRAMWAY

MOTOR TESTS

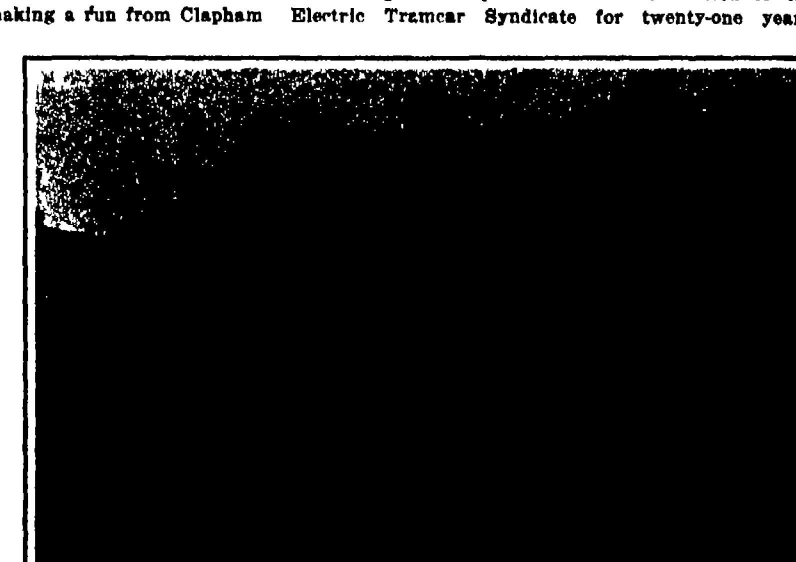
Ninety storage traction cells were used of the lead type with aluminium fittings

1 A current of 30 amperes was passed through the single motor and gave a torque or 60 pounds

2 Fifty amperes was next put through the same motor and gave a torque or 97 pounds

3 The motor was coupled as the inventor had designed All the windings being in series a current of 28 amperes was passed through which gave a torque of 117 pounds The above tests were made many times over upon a Prony brake These tests proved conclusively the economy in power production by this particular construction of motor At the latter end of September 1890 a thorough test of this car was made by making a run from Clapham Common to Tooting and back (at that time a new extension of the London Tramways Company's line) The number of passengers was 44, including several electricians from the Brush Electric Light Company and their chairman, the late Duke of Marlborough; the chairman of the London Tramways Company, D. P Sellar and all the directors, road surveyors, and engineers. The car was put to every test suggested, with complete success, with no hitch whatever Balham Hill was ascended upon the return journey which consists of a variable incline of 1 in 18 to 1 in 22 the current never exceeding 50 amperes, while as a further test this car pushed a horse car in front up the hill in addition to its load of 44 passengers. When running upon a level with wetted rails 5 to 8 amperes was the only energy used the speed being at the rate of ten miles per hour An exact account of this run was given in the Electrical Review London October 3rd 1890 .This car could be run off the rails put around a breakdown and on to the rails again Provision for this unusual work to be accomplished was made by the use of a pair of ramping irons and a lateral movement of the front axle the axle box being made specially for this purpose The cost of working by this storage system has been well tested and proved during a period of eight years When the time came for its general adoption upon the Clapham Tooting extension as stipulated and in accordance with the written promise of the tramway company (under a guarantee of eight and a half cents per mile) the London Tramways Company backed out and would not adopt it although their premises had been leased to the Electric Tramcar Syndicate for twenty-one years their excuse being that they had only six more years to run with their lease from the local authorities and thus an excellent, well-tested system came to a standstill after $15,000 had been spent, and eight years of incessant labor. These storage [illegible] like the Edison, and many [illegible] [illegible]

DISCARDED LONDON TRAMWAY HORSE CAR MADE INTO AN ELECTRIC PASSENGER CAR



VIEW OF ELECTRIC CAR PERFECTED THROUGH IMPROVEMENTS MADE ON CAR AT THE LEFT

York, were adopted The electrical efficiency of the motor proved to be 94 per cent in all the workshop tests. Although two of these cars were thoroughly tested afterward in every-day traffic upon the Croydon Tramway Company's lines running from Thornton Heath to Crown Hill on time with the horse cars the little syndicate was denuded of capital from the previous experience Entirely through these difficul ties the running of these cars ceased although many meritorious parts of the invention are being adopted by others to-day in electric traction The battery was lighter than any hitherto made and of high efficiency

Forms for Concrete

Schemes for Saving Time, Labor, and Lumber

SINCE freshly mixed concrete is a plastic material forms of some kind are necessary to hold it in place and in shape until the cement sets up and the con crete becomes hard. Lumber though expensive is the material most commonly used By exercising his natural ingenuity and customary care in the matter of construction of forms, the farmer has built so cheaply of concrete that his cost statements are frequently doubted by the builder in the city

Much of the work done on the farm requires almost no forms at all In this class are walks floors in buildings, and feeding floors.

The first requisite of good forms is that they should be tight, so that the liquid cement may not run out between the cracks, cause pockets or hollows and thus ruin the looks of the work as well as decrease its strength Consequently straight boards are most desirable unless one chooses to fill gaping cracks with stiff clay and tack strips over them. Dressed lumber is usually straightest and yields a neater finish to the concrete But for ordinary purposes rough lumber is sufficiently good Naturally the siding must be stiff enough not to bulge out of shape when the forms are first filled with concrete This does not mean that very heavy siding is necessary In fact 1 inch boards are usually sufficiently strong The bulging may be prevented by setting 2 by 4 inch studding from 20 to 30 inches apart according to the thickness of siding boards or sheathing used

The thoughtless cutting of boards into short lengths means a waste of lumber and a useless increase in the cost of concrete Unnecessary nailing not only calls for more nails but adds to the difficulty of removing and the danger of splitting and ruining the boards The reason that concrete is so unusually cheap for the farmer is that he plans his forms to spoil as little lumber as possible and he finds a use for all of the lumber after it has served to hold the concrete in place In this way the material for forms costs practically nothing.

Most concrete work on the farm is built in what is known as the *box form* which with variations consists of one box within another between which the concrete walls are molded Such forms are used especially for walls of buildings tanks and troughs Ordinarily the studding need not be cut in lengths equal to the height of the wall it may without inconvenience be allowed to project above the top of the siding. Nor does it need to be sharpened (and later battered up at the other end) for driving into the ground There is a quicker easier and cheaper way Set the ends of the studding on the ground and hold them in their proper position by a timber called a *liner* lying on the ground against them or toe-nail the ends of the studding to a plate which will serve the same purpose Stakes driven into the ground and against the plates or liners will fix them firmly in place. The studding may be held plumb by bracing it with odds and ends running from the top to stakes driven into the ground a few feet away from the form. If the forms are so high and will be filled so rapidly as to render possible the springing of the studding, tie the opposite pieces together by [illegible] of bolting or other pliable wire passed through the joints in the siding Space the forms at the top by means of cross cleats

For the outside wall of box forms boards of full length need not be cut at all The extra length may be allowed to extend beyond the corners This saving cannot always be effected with the inner wall yet odd pieces of boards may often be used in such a way as to prevent useless cutting In railing on

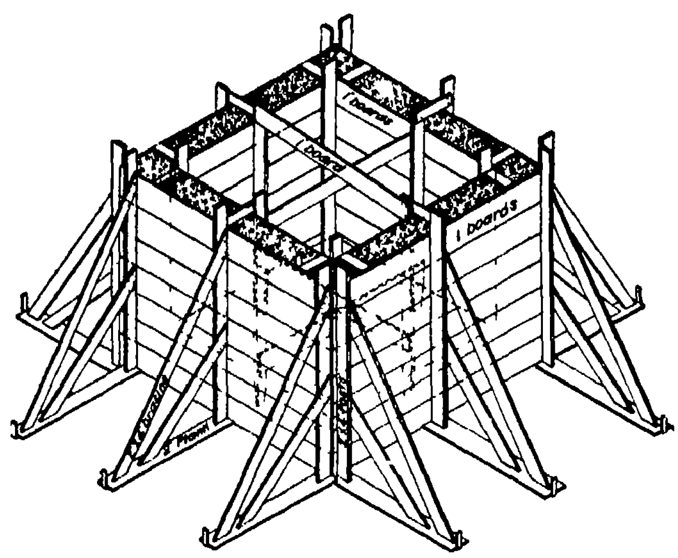


DIAGRAM SHOWING FORMS FILLED WITH CONCRETE

the siding arrange the boards so that all end joints will not be made on the same upright If the lumber is crooked draw the boards together so as to prevent cracks Since the siding is generally between the studding and the concrete heavy nailing is not needed to hold it in place until the concrete comes against it Often cleats clamps or screws are used to save the lumber and to render easier the removal of the forms The forms should always be planned with this end in view In placing the concrete avoid unnecessary lifting by leaving off a few of the boards at the top of the form until they are needed However if chips or blocks fall inside the forms carefully remove them before proceeding with the work.

See that the forms are lined up properly before beginning to fill them as they *must not* be disturbed after the concrete is in place

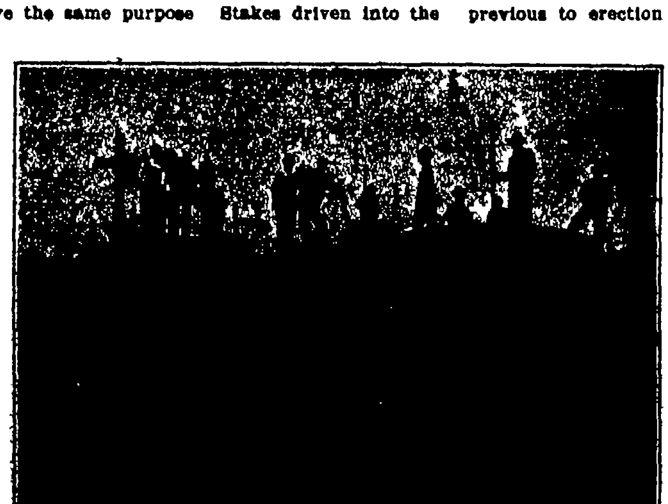
If new forms are wet, before the concrete is placed and allowed to remain in position until it has thoroughly set bits of concrete will seldom stick to them For very particular work or where forms are to be used more than once it is advisable to coat them previous to erection with soft soap or oil Linseed black, or cylinder oil is suitable but kerosene is not good Upon taking down the forms immediately clean off all bits of concrete clinging to them For this purpose a short handled hoe is convenient, but it must be used with care so as not to gouge the wood

All other things being equal the strength of concrete is dependent upon its density or compactness. Where possible, the easiest way to render concrete dense is by mixing and placing it wet. For very wet concrete the forms must be tight so that the liquid cement cannot escape To give a neat finish to the surfaces which will later be exposed force the larger stones back from the outside by running a straight spade or a wooden paddle down in the concrete next to the wall forms and working it back and forth

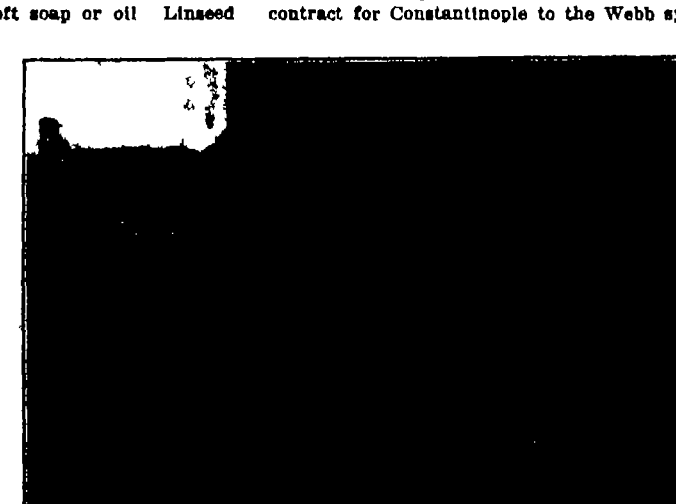
It frequently happens that very wet concrete cannot be used To make a drier mix dense and strong tamp or ram it into place with a heavy wooden or iron tamper

In a way the successful making of hay and concrete are very much alike—both must be well cured Exposed surfaces of freshly placed concrete should be shaded to protect them from rain dust, and the hot rays of the sun Freezing injures freshly placed concrete Hot water and salt are sometimes used to counteract the frost action but on the whole it is better to attempt no outside work in winter During the early months of spring and fall see that no frozen sand gravel or rock is used in the work *In summer* ordinary forms for walls supporting no loads may be removed after the concrete is three days old but *in cooler weather* they should not be touched short of five days

It is the attention to the details which makes farming or any business a success The same principle holds true of concrete work



AN ILLUSTRATION SHOWING FORMS FOR ROUND CONCRETE TANKS



VIEW OF CONCRETE FORM WITH BOARDS PROJECTING BEYOND CORNER

The Turkish government has awarded the telephone contract for Constantinople to the Webb syndicate for the space of thirty years The syndicate includes the Bell and other American interests As regards the electric lighting contract for the European quarter and suburbs the Sultan has ratified the decision awarding it to the Austro Hungarian Ganz Company backed by a strong syndicate composed of the Hungarian Bank along with French and Belgian capital. The contract figures at $4,000,000.

Balloon Signals*

An Important Aeronautic Consideration

LARGE airships have for some time been provided with wireless signaling apparatus and small air ships are now being similarly equipped Spherical balloons open below can carry wireless receivers but transmitting apparatus is excluded by its size and weight and by the somewhat questionable danger of explosion The usefulness of receiving apparatus alone hardly justifies its cost for it includes a wire several hundred yards long hanging from the car and a double wire loop surrounding the gas bag or preferably a metal plating extending over an equatorial zone or the upper half of the bag

An excellent but little used means of communication between balloons is afforded by luminous signals directed by a Morse code The same method could be employed for communicating with the earth in many cases A Nernst or other powerful incandescent electric light would be appropriate for a motorless balloon and an electric arc screened by wire gauze on the principle of the miner's safety lamp would yield a brighter light for airships The arc lamp could be operated by a small dynamo driven by the airship motor The incandescent lamp of the motorless balloon could be fed by Edison storage batteries suspended from the car in a bag and forming part of the ballast For signaling to considerable distances telescopes and parabolic mirrors or projecting lenses are required The signals can be made by opening and closing a shutter

The range of communication depends on the power of the lamp and the size and quality of the mirrors or lenses and telescopes Great distances can be attained at night and in daylight the range is at least equal to that of a Zeiss triple mirror of the same aperture Theoretically the range is four times that of a triple mirror used with the same source of light and equal to that of a triple mirror using a lamp sixteen times more powerful than the lamp employed with the system described above

The Zeiss triple mirror is a device for sending signals by the reflection of light produced at the receiving station It consists of a triangular pyramid of glass in which the three faces that meet at the vertex are mutually perpendicular like the three faces that meet at a corner of a cube The light enters the pyramid through its fourth face or base through which it also emerges after successive total reflections at the other three faces This combination of three mutually perpendicular mirrors almost exactly reverses the course of a beam of light even when the beam is not exactly normal to the base of the pyramid i e when the triple mirror is aimed only approximately at the source of light.

By means of this device, an unlighted balloon can send messages to a station which emits a steady light and conversely an unlighted station can give an immediate response to the inquiring flash of an airship's searchlight In either case the Morse code can be used by covering and uncovering the triple mirror

Variations in the position of the mirror do not affect the course of the reflected beam, unless these variations exceed the angular range within which a ray can be reflected from all three internal faces A person looking into the triple mirror sees a reflected image of his face which remains motionless when the mirror is moved turned or oscillated within its range of action Hence it is easy to obtain and maintain communication with the receiving and light-giving station

If the three reflecting surfaces are not quite perpendicular to each other the triple mirror serves also as a telemeter The effect of this construction is to divide the reflected light into two beams which diverge very slightly from each other and are seen at the receiving station to the right and left of the source of light, and separated from it by a distance proportional to the distance between the two stations

If for example, the ratio is 1 to 10 000 and it is found necessary to place the eye 12 inches to the right or left of the center of the lamp in order to see the flash of the triple mirror the distance between the two stations is 10 000 feet The range of signaling depends upon the intrinsic brightness (per unit of surface) of the source of light, and the aperture, or effective diameter of the triple mirror

The mirror here shown has a range in average atmospheric conditions of about 3 miles by day and 9 miles by night when used with a Zeiss 10-inch signal lamp These ranges can be doubled by employing an electric searchlight having four times the brightness of the signal lamp

The electric arc is the brightest of our artificial sources of light With sunlight a range of at least 37 miles could be attained but it would be necessary to throw the light upon the triple mirror by means of two very perfect plane mirrors operated by two persons as the motions of the sun and the balloon cannot be followed simultaneously with the simple army heliograph in which the two mirrors are rigidly connected

Without using sunlight the range can be extended by increasing the size of the triple mirror A 6-inch mirror would have a range of over 9 miles by day and nearly 28 miles at night A solid glass pyramid of this size would however be inconveniently heavy Hence the Zeiss firm has patented an arrangement of several triple mirrors, mounted on a board in square order and producing the effect of a single large triple mirror Such an arrangement of four triple mirrors, of 4 inches aperture, would have a range of about 12 miles by day and 37 miles at night.

A great advantage of the method of signaling with the triple mirror is its absolute secrecy for the messages cannot be received by any person except the observer standing beside the source of light. Yet any warship can throw its searchlight on a military balloon and receive secret information

Communication with scouting airships many miles in advance must be carried on by wireless telegraphy The secrecy of the messages can be assured only by an intricate cipher code as the direction of the electric rays cannot yet be satisfactorily controlled. Even the system of Losi and Bellini gives merely a greater range in one direction than in others. Disturbance by other stations and the impossibility of identifying the sender of a message are additional defects of wireless telegraphy The optical system is far superior within its limited range of 30 miles, and this range covers the most important military communications. The two systems should supplement each other

In daylight, conversation can be carried on secretly, by the Morse code between a station equipped with a searchlight and a balloon carrying a Zeiss triple mirror for the beam of light cannot be traced in the air and neither the signals sent to the balloon by intermittance of the outgoing light nor those sent from the balloon with the mirror could be interpreted by an airship which might momentarily intercept the rays in its flight At night, messages can still be sent secretly from the balloon but the secrecy of messages sent in the opposite direction may be destroyed by the visibility of the searchlight's beams (In clear weather the beam is not visible to a height much greater than 3 000 feet)

There is however a possible method of sending secret messages over a visible beam of light This method is called photophony and it involves the employment of selenium cell and other receiving apparatus which however does not weigh as much as a large triple mirror A few months ago the range attainable by this method, which was barely 5 miles was greatly increased by the invention of the telephone relay by Brown, in England It is claimed that the loudness of a telephone message is multiplied twenty fold by the insertion of one telephone relay, and four hundred fold by two relays Hence it may be expected that a practical system of communicating over great distances by means of the photophone and the telephone relay will soon be developed

* Abstract of a paper read by C von Salviati before the Aeronautical Congress in Dresden

Celebrated Echoes

ONE of the most famous echoes is that heard from the suspension bridge across the Menai Strait in Wales The sound of a blow from a hammer on one of the main piers of the structure is returned in succession from each of the cross beams that support the roadway and from the opposite pier at the distance of five hundred and seventy six feet In addition to which the sound is many times repeated between the water and the roadway at the rate of twenty-eight times in five seconds

Outside the Shipley Church in Sussex, England, is an echo that repeats twenty syllables in a most extraordinary manner The famous echo at Woodstock when awakened answers no less than fifty times

The whispering stone in Statuary Hall in the Capitol at Washington was possessed of a curious echo A person speaking in a whisper near the stone would hear his words repeated from the extreme end of the hall Reconstruction and rearrangement of the hall has changed all this to a great extent.

The echo in the castle of Simonett, about two miles from Milan in Italy repeats the report of a pistol fifty times and in the Abbey Church at St Albans in England the ticking of a watch may be heard from one end of the edifice to the other

In the Cathedral of Girgenti in Sicily the slightest whisper is carried with perfect distinctness from the western door to the cornice behind the altar a distance of two hundred and fifty feet Curiously enough, at one time the confessional was so placed that the echo of the voices of those who were confessing could sometimes be overheard by the congregation Later the confessional was removed to another part of the church.

In the whispering gallery of St. Paul's, in London, the faintest sound is faithfully conveyed from one side of the dome to the other, but cannot be heard at any intermediate point.

The Manfroni Palace at Venice possesses a square room about twenty five feet in height. It is fitted with a concave roof Standing in the center of the room a person stamping softly on the floor hears the sound repeated a great many times, but as his position deviates from the center of the floor the reflected sounds grow fainter and fainter until they die out entirely The same phenomenon occurs in the large room of the Museum at Naples

In the Gloucester Cathedral in England a gallery of an octagonal form conveys a whisper seventy five feet across the nave

The Hollow Lake region of Ontario, in Canada, is fairly alive with echoes On certain days a paddle dropped in the bottom of a canoe will sound as though several battleships were busily engaged in bombarding the place

Can a Solid be Superheated?

IT has never been found possible to superheat a solid, that is, to heat it above its melting point without melting it. Notwithstanding this negative result, some chemists, notably Ostwald, admit the possibility of superheating a solid and attribute the failure to do so to defective conditions of experiment. A Swiss scientist, A Berthoud, has lately taken up the question He shows that Ostwald's conclusions, based on a false interpretation of some experiments of Frankenheim with hydrated sodium chloride, have no justification and that Ostwald's opinion contradicts the theory, now generally admitted, which attributes retardation in change of state to the action of capillary forces.

According to this theory, if solidification, for example, does not take place, in the absence of germs, at the normal fusing point, this is because the very small solid particles which are first formed have a very large surface in proportion to their volume, and therefore possess a very great superficial energy. [illegible] formation is associated with an increase of free energy and cannot take place in the absence of such increase By adding to the supersaturated liquid a particle of the solid substance, the first phase of the transformation, which cannot take place spontaneously, is accomplished and the solidification then goes on regularly If this theory is admitted, it becomes necessary, in order to explain the impossibility of superheating a solid, to ascertain why capillary forces are not manifested in the act of fusion The reason, according to Berthoud, is that the liquid resulting from the fusion wets the solid Let us consider a piece of ice at the melting point. A drop of water placed upon the ice extends over the surface, so the boundary between ice and air is replaced by one between ice and water and one between water and air This spontaneous phenomenon is associated with a diminution of the superficial energy, instead of an increase, so that the cause which in congelation, evaporation, etc., retards the change of state, to wit, an increase of superficial energy does not exist in the case of fusion. Hence, fusion necessarily takes place, without priming, as soon as the fusing point is attained. Superheating could only take place with a solid which is not wetted by its liquid.—Revue des Science.

The production of tin-plates and terne-plates in 1909 in the United States is estimated at 612,951 tons, as compared with 537,087 tons in 1908, an increase of 75,864 tons. Of the total in 1909, 527,714 tons were tin-plates, as compared with 468,297 tons in 1908, an increase of 59,417 tons, and 85,236 tons were terne-plates, as compared with 68,[illegible] tons in 1908, an increase of 14,[illegible] tons. In addition to tin and terne plates, [illegible] lead-coated and [illegible] sheets [illegible] [illegible]

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A printed copy of the specification and drawing of any patent in the foregoing list or any patent in print issued since October 4th 1859 will be furnished from this office for 10 cents provided the name and number of the patent desired and the date be given Address Munn & Co Inc 361 Broadway New York

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list For terms and further particulars address Munn & Co Inc 361 Broadway New York

Electrical Notes

Electric elevators for subways have not as yet been used on the Paris lines but two of the new stations are now equipped with them The stations lie on the part of the line which crosses the Seine near Notre Dame by means of a metallic caisson tunnel sunk from the surface The two stations contained in the caisson work have been opened for service quite recently and it is here that the elevators have been installed owing to the number of staircases which need to be climbed It will be some time however before the elevators are set running

Among the large steam turbine plants in Europe may be mentioned the St Denis station near Paris and there are now ten turbines in use since the late increase These are of the 100 000 size A larger one of *16 00 horse power has been added All the turbines* are coupled to dynamos At the Milan station there are now four turbines of 8 000 horse power and three others making 4 000 horse power in all In Germany the [illegible] no Westphalian Company is running two units of 10 000 horse power and five of 5 000 horse power All these turbines are of the Brown Bovert type on the Parsons principle

Much more light for a given power can be obtained from a mercury vapor lamp provided it is worked at a higher temperature than usual However the glass melts when we attempt to do this On the continent a quartz mercury lamp is now made for the purpose and it can be run at a high heat without danger of the quartz melting The light is much better and approaches a yellow hue and the glowing quartz adds red rays which improve the color It is claimed that such a lamp is as economical as a flaming arc lamp and therefore stands near the head of the list among all electric lamps It has none of the objections which make the arc more expensive on a early run on account of renewing carbons and cleaning globes

In a paper presented to the Academie des Sciences M E Salmon describes his new researches for causing reactions between bodies in the electric arc He uses an arc between tubular carbon electrodes so that the gas arrives by one tube and the products of the reaction are led off by the other The apparatus consists of a quartz tube 8 inches long closed at the ends by quartz stoppers having a 0 7 inch hole The stoppers are luted on with plaster Carbon tubes of 0 [illegible] inch diameter are held in the stoppers by asbestos sheet so that they can be slid by hand to keep up the arc The quartz tubes which are about 1½ inch diameter resist the heat of the arc very well By this arrangement the gases must pass through the arc it self before leaving at the other side which is best for the reactions He first realized some already known experiments such as combination of hydrogen and carbon to form acetylene etc The following results appear to be new He secures the direct combination of nitrogen and carbon Starting the arc for half an hour at first he then passes a current of dry nitrogen through it The resulting product was passed into a potash solution As the solution was found to give a precipitate of Prussian blue with hydrochloric acid this proved that cyanogen was formed by the arc and then absorbed by the potash to give cyanide and cyanate The direct formation of cyanogen is thus to be noted Second it is known that copper does not decompose water when at furnace heat to any appreciable extent However the heat of the arc gives a decided result Using an arc between a pair of copper tubes he collected quite a measurable amount of hydrogen in a few minutes Melted copper oxide was produced at the same time Thus he produces a decomposition of water which cannot be realized at lower heats

Science Notes

At Alise-St. Reine, France, Commandant Esperandieu discovered a small temple of hexagon form It contained a pool which was fed by a spring and this spring still exists here No doubt the water was supposed to have healing qualities seeing that votive offerings were found in the pool in the shape of images representing eyes and fingers according to the custom A number of marble busts were found on the spot Seeing that the coins which came to light here stopped at the reign of Marcus Aurelius in the year 166 A D the edifice was no doubt destroyed at that date

Dr Cartier reports to the Academie des Inscriptions as to a recent find in the North African region near Souk el Arba He uncovered a subterranean palace which was very well preserved It is of the Roman period and contains intact vaulting a Corinthian colonnade and several fine mosaics which have not as yet been all uncovered One mosaic shows a female portrait of attractive appearance while another has two Cupids mounted upon dolphins with a framing composed of a fish design He is continuing the work at present

Tunisia produces a variety of fruits which may be divided into three classes First oranges, mandarines and lemons second almonds and olives, and third orchard fruits such as peach apricot pear apple etc We also mention pomegranates and figs which are cultivated rather by the natives than by Europeans *Most of the orange crop is sold in the country and* but little is exported The almond and olive cultivation is on the increase and new plantations have been made within the last ten years Almonds are largely exported and Tunisia produces 600 000 pounds of almonds yearly exporting 400 000 pounds The present exports of dried figs are 100 000 to 140 000 pounds

M. Vournasos brings out a method for obtaining hydrogen arsenide gas by the action of formate of soda in the dry state upon arsenic and its compounds at a temperature of 400 deg C This method is not only applicable to the production of the gas but it can also be used as well as the Marsh apparatus for toxicological research for arsenic To prepare the gas the author recommend using 3 parts of arsenic in powder or arsenite of soda and 8 parts of formate of soda

CONCRETE

REINFORCED CONCRETE and CONCRETE BUILDING BLOCKS

Scientific American Supplement 1543 contains an article on Concrete by Brysson Cunningham The article clearly describes the proper composition and mixture of concrete and gives results of elaborate tests.

Scientific American Supplement 1538 gives the proportion of gravel and sand to be used in concrete

Scientific American Supplements 1567 1568, 1569 1570, and 1571 contain an elaborate discussion by Lieut Henry J Jones of the various systems of reinforcing concrete concrete construction and their applications. These articles constitute a splendid text book on the subject of reinforced concrete Nothing better has been published

Scientific American Supplement 997 contains an article by Spencer Newberry in which practical notes on the proper preparation of concrete are given

Scientific American Supplements 1568 and 1569 present a helpful account of the making of concrete blocks by Spencer Newberry

Scientific American Supplement 1534 gives a critical review of the engineering value of reinforced concrete

Scientific American Supplements 1547 and 1548 give a resume in which the various systems of reinforced concrete construction are discussed and illustrated

Scientific American Supplement 1564 contains an article *by Lewis A Hicks, in which the merits and defects of* reinforced concrete are analyzed

Scientific American Supplement 1551 contains the principles of reinforced concrete with some practical illustrations by Walter Loring Webb

Scientific American Supplement 1573 contains an article by Louis H Gibson on the principles of success in concrete block manufacture, illustrated

Scientific American Supplement 1574 discusses steel for reinforced concrete

Scientific American Supplements 1575, 1576, and 1577 contain a paper by Philip L. Wormley Jr on cement mortar and concrete their preparation and use for farm purposes The paper exhaustively discusses the making of mortar and concrete depositing of concrete facing concrete wood forms, concrete sidewalks, details of construction of reinforced concrete posts.

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Trade Notes and Formulae

Washed clothes, bleached with chlorine (chloride of lime or bleaching powder) can with difficulty be freed from chlorine even by repeated rinsing, and if put away holes are very likely to be eaten into them If the washed linen after rinsing is passed through anti-chlorine all the chlorine will be fixed and the linen will not be injured by the bleaching Anti chlorine is prepared by dissolving 1 part of hyposulphite of soda in 10 parts of water

Water Colors.—Water colors prepared with gum or dextrine form hard solid masses that can only be softened after prolonged rubbing with the moistened brush To obtain water colors that will always be soft and can be readily taken up by the brush a solution of sugar should be used containing from 2 to 10 per cent of the weight of the sugar used of pure concentrated glycerine As the latter constantly absorbs moisture from the atmosphere colors prepared in the manner described never become perfectly hard By using thick solutions of gum to which glycerine has been added and with which the color has been rubbed down we obtain water colors which can be put up for sale like oil colors in tin capsules (tubes) and are always ready for use

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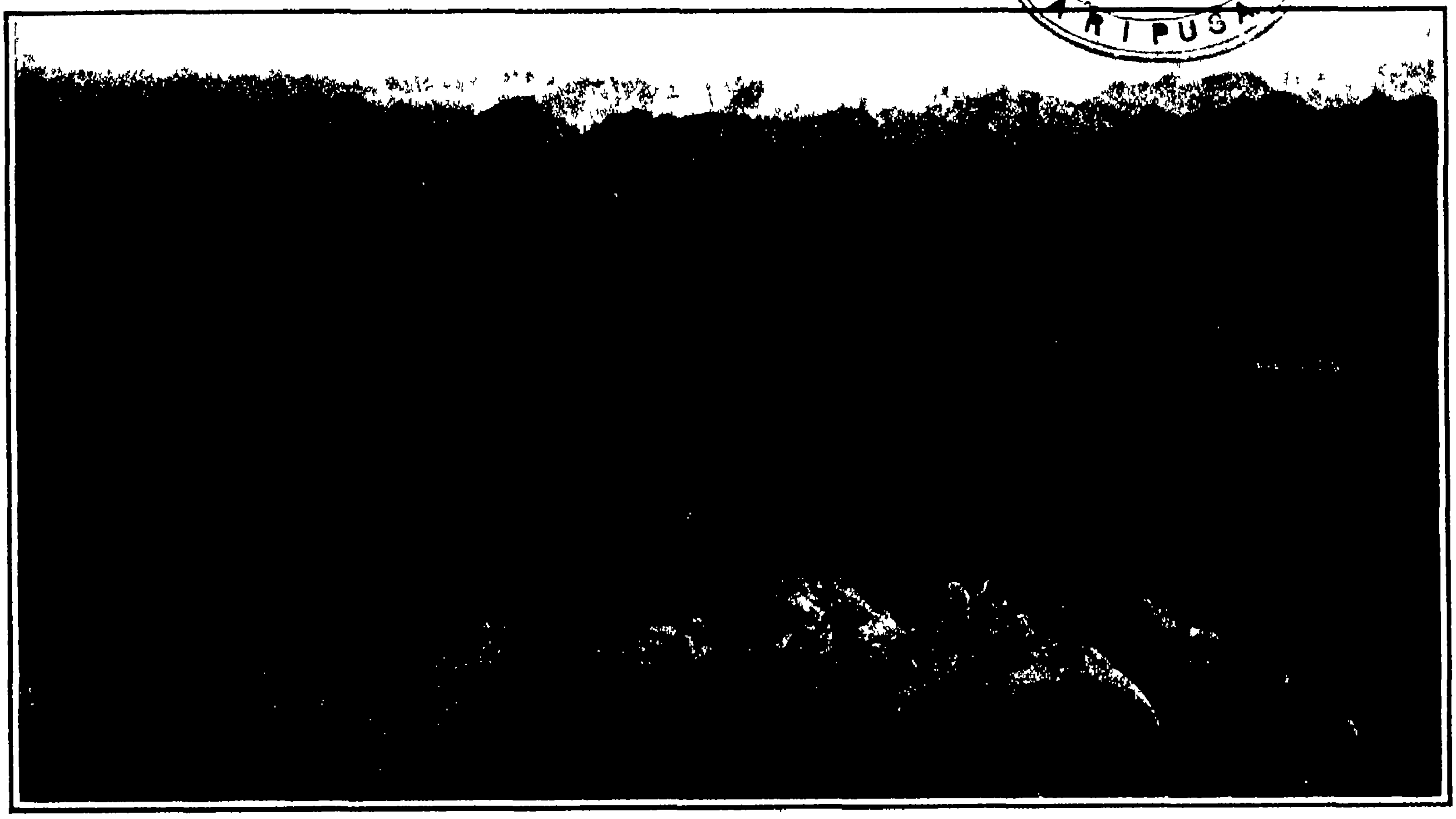
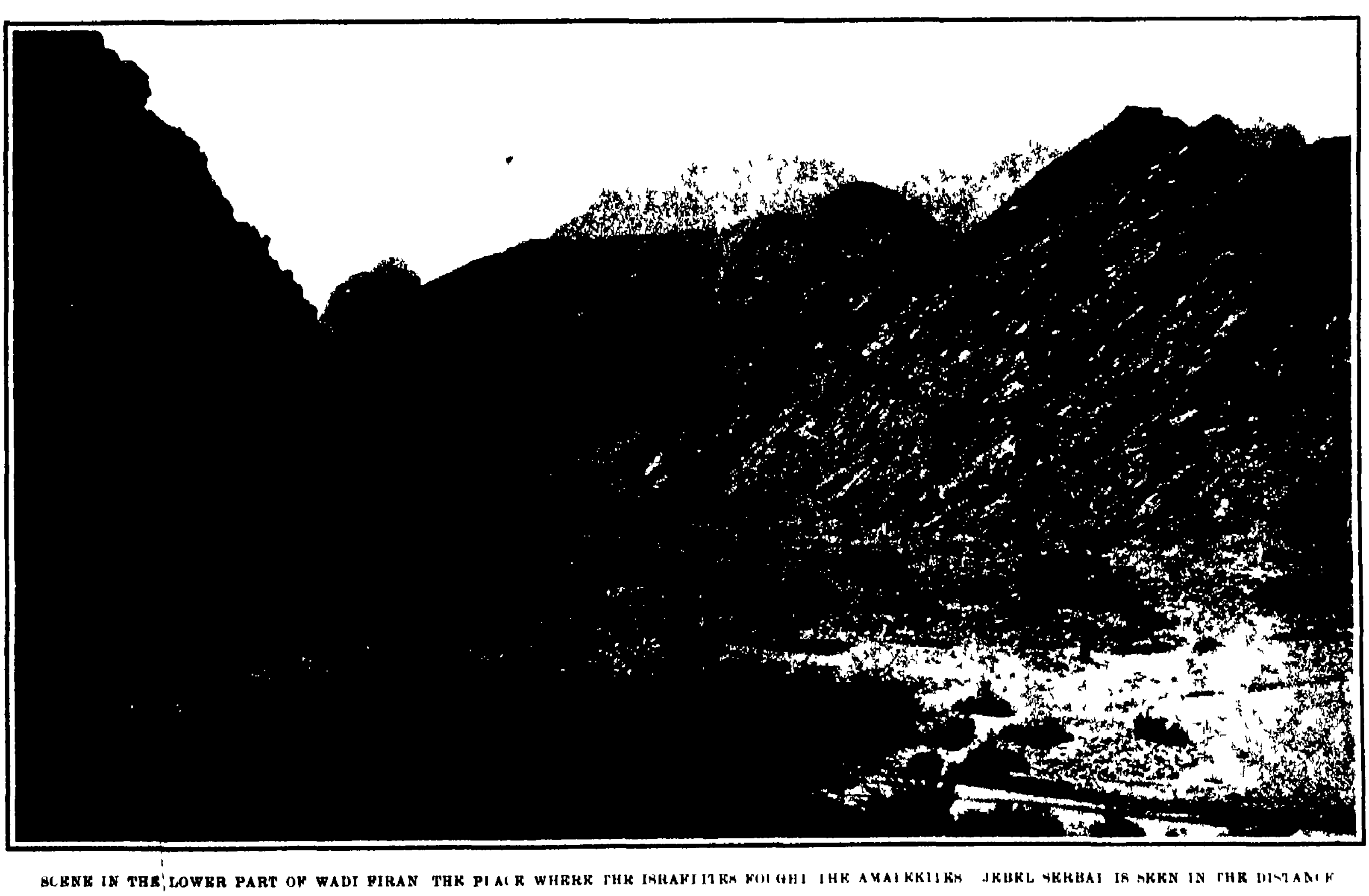


A TYPICAL VIEW OF THE BARREN AND AWE-INSPIRING MOUNTAINS OF SINAI, TAKEN LOOKING NORTHEAST FROM THE SUMMIT OF JEBEL MUSA



SCENE IN THE LOWER PART OF WADI FIRAN, THE PLACE WHERE THE ISRAELITES FOUGHT THE AMALEKITES. JEBEL SERBAL IS SEEN IN THE DISTANCE

THE "HOLY MOUNTAIN."—[See page 40]

The Development of Submarine Boats—II

From Bushnell to Holland and Lake

By Simon Lake

Concluded from Supplement No. 1828 page 26

The author is free to admit that there are certain mysteries connected with the control of submarine vessels in a vertical plane that are not easily explained While the problem of perfect control of such vessels in a vertical plane by the use of hydroplanes was solved on the first submerged trials of the Protector held early in 1903 at which time it was discovered that the Protector would maintain her depth automatically for considerable periods of time the importance of the exact location of the hydroplanes was not at that time fully recognized nor appreciated until the trial of the Lake in 1907 which vessel was largely a duplicate of the Protector but owing to certain overweight that crept in—primarily owing to the fact that the location of the hydroplanes had been changed from that of the relative position of the hydroplanes in the Protector —she would not submerge nor run on a level keel and it required constant manipulation of the horizontal rudder to keep her submerged When the overweight was removed and the position of the hydroplanes changed she performed satisfactorily as a level keel boat

For the purpose of observing the stream lines passing over a boat while in the submerged condition the author constructed an experimental tank in Berlin a few years ago and built models of various forms for the purpose of watching the action of the models when submerged as it was impossible to observe the stream lines if the model was pulled The tank was so constructed that the water could be driven by the model at a constant velocity by the use of propellers the velocity of the stream could be increased or diminished as desired

A model of the Protector submerged was tried out in this tank The model was free to move up or down a transverse shaft running through the model at a point half way between the centers of buoyancy and gravity wheels were fixed to the outer ends of this shaft These wheels ran up and down on vertical wires on either side of the model On the reserve buoyancy being reduced in the model to about that used in the full size boat the hydroplanes would cause the boat to submerge or emerge on a level keel in the same manner as the full size l ship It was found that with a certain inclination of hydroplane the vessel would submerge to a certain depth and automatically maintain that depth as long as the velocity of the stream was fairly uniform To go deeper required a greater angle of hydroplane or horizontal rudder Just why a vessel will submerge only to a given depth with a certain angle of hydroplane is not altogether clear At the time these tank experiments were made this fact did not impress itself on the author's mind as much as it has since due to some recent trials with one of our foreign boats which was submerged with a reserve buoyancy of about 600 pounds When first submerged it was running with an inclination down by the bow of about 1 degree The boat ran for thirty minutes maintaining a constant depth of between 31 and 32 feet without touching either the horizontal rudder or the hydroplanes It was then noticed that the boat had changed her trim for 1 degree down by the bow to 1 degree down by the stern which was gradually increasing Still the boat maintained her uniform depth A movement of 1 degree of the horizontal rudder brought her to a level keel When she showed a tendency to submerge further 2 degrees less inclination to the hydroplanes brought her back to her original depth with head of periscope about 1 foot above the surface and she ran thirty minutes more without touching anything at which time she had again taken on an inclination of about 1½ degrees down by the stern The boat was stopped and it was found that she had lost all of her reserve buoyancy except about 10 pounds and that a leaky valve had let about 600 pounds of water into the exhaust tank at the extreme after end of the boat. At rest she took an inclination of 5 degrees down by the stern

Here was a condition that had never been previously noted in the author's experience where the vessel ran at a uniform depth without touching anything during which time she changed her reserve of buoyancy and changed her trim and yet maintained a constant depth

This same phenomenon was later observed in another Lake boat where by moving men from one end of the boat to the other the trim would be changed from down by the head to down by the stern but the depth would remain constant without changing inclination of horizontal rudder or hydroplane

* Proceedings of the Engineers Club of Philadelphia.

With a certain reserve of buoyancy and a certain inclination of hydroplane therefore the vessel will always go to a corresponding depth and run constant at that depth until conditions are changed Indeed the author has heard the commander of one of these boats state for the information of the members of a trial board after first noting the vessel's reserve of buoyancy I will now set the hydroplanes at 10 degrees down and the horizontal rudder 2 degrees up and the boat will submerge to a depth of 30 feet and run constant at that depth which the vessel did without his touching anything after she started to submerge

The testing tank also showed up another curious thing A model of one of the early United States boats of the Adder type with the cigar form of hull and with quite a considerable surface buoyancy would automatically dive by the head at an angle of about 30 degrees when the bow would lightly touch the bottom of the tank and then she would reverse her inclination and come to the surface at about the same angle at which she dived At times she would reverse without touching the bottom This model had a metacentric height corresponding to about 10 inches in a full-sized ship It was very interesting to observe this porpoise like motion which kept up continuously as long as the stream was flowing and it was impossible to set the horizontal rudder in any position to overcome this tendency The porpoising motion was so rapid that it was impossible to get any accurate observation of the stream lines but it is believed that the explanation is much the same as of the hydroplane action viz as the vessel gathers headway the water piles up over the cigar-shaped bow which combined with the increased frictional resistance due to the streams passing under the hull causes the bow to submerge and the vessel plunges toward the bottom A cross section parallel to the surface through the hull near the bow as she is diving would show if she was moving forward at the same time) that there would be a tendency to create a vacuum under the forward portion of the vessel which would tend to increase the inclination and she would continue to dive until a sufficient inclination and depth was reached whereby the greater head of water at the bow reduced the vacuum and consequent down pull on the bow and at the same time the vacuum formed under the stern was proportionately increased which combined with the righting effect of the pendulum arm (her metacentric height) caused the forces to be reversed and she would broach to the surface The motion of the model would apparently synchronize and the plunge toward the bottom and return to the surface again would occur with the regularity of clockwork The obvious remedy for this tendency in a boat of the cigar shaped form is to increase the metacentric height and the size of the control rudders and to keep in constant touch with the horizontal rudder

The above theory may explain the fatal dives to the bottom of some of the vessels of the diving type

One of the advantages of bottom wheels in surmounting obstructions is in running in waters not well charted where it is assumed that there are several fathoms of water the keel striking and surmounting obstructions of unknown objects The cushioning wheels take up the shock and the vessel surmounts the obstruction without the hull coming in contact with the object

Speed as every engineer knows is simply a question of lines and horse power The author has always felt that safety and ease of control should be the first consideration in the design of submarines The submarine does not require great speed especially under water The submarine is the guerilla in warfare and it is her province to lie in wait for her fleeter foe the armored cruiser or the battleship For preventing a close blockade of a port a very slow submarine would have frequent opportunity to intercept a blockading squadron. Speed is now becoming more desirable, however as the submarine is going to take the offensive in naval warfare rather than the purely defensive position to which these vessels have been considered adaptable

In the author's opinion the proper method of making a submarine attack is for the submarine to run on a level keel a sufficient distance below the surface so that when the omniscope and periscope are withdrawn there is absolutely nothing on the surface to betray the fact that a submarine is in the vicinity.

The vessel which carries six of the deadly Whitehead torpedoes, all of which may be almost simultaneously fired two at the bow two at the stern, and two to either broadside. The periscope is kept housed except at the moment of taking an observation Range-finding and direction indicating devices are provided by means of which the navigator of the submarine may be constantly advised as to the position of the enemy Observations may be made by suddenly shooting the head of the periscope just slightly above the surface and as rapidly withdrawing it An observation may be taken and the distance of a known ship calculated in a space of time not exceeding two or three seconds during which period no gun could be trained on so small an object as the head of a periscope even if it was observed which in a choppy sea is hardly likely even at a distance of only 300 or 400 yards and at a distance of a couple of thousand yards would be invisible even with a very powerful glass provided the vessel did not have sufficient speed and the periscope did not remain above the surface long enough to create a wake It is the wake of the periscope which attracts attention to a vessel running with the periscope above the surface all the time

DISCUSSION

In reply to questions by members Mr Lake stated as follows

All of the French boats so far have been built in France and all of the recent French designs have been made by French officers He thinks that Goubet the designer of a little French boat shown experimented privately The United States Government has furnished no designs Its latest call for tenders distinctly states that the Government has no designs

Reference was made to what is known as the Board on Construction which has been discontinued There is now a General Board of which Admiral Dewey is the head The Board on Construction was composed of the heads of the Bureau of Construction the Chief of the Ordnance Bureau the Bureau of Engineering the Bureau of Equipment and the Chief Intelligence Officer These men would get together and decide on all classes of ships except submarines which class was formerly decided upon only by Congress The Naval Board formerly had nothing to do with this due to the wording of the legislation Now however it does and the Department issues circulars to ship builders and specifies what it wants in the way of armament and performance Since the United States has the advantage of getting competitive bids the requirements are as severe as if not more so than those of any foreign government.

The difference between a horizontal rudder and a hydroplane is this A horizontal rudder is placed at the bow of the boat or at the stern and has simply a guiding function to direct the course of the vessel up or down The hydroplanes pull the boat up or down bodily as it were In the Lake type of boat they have always been equally distributed one an equal distance forward and another an equal distance aft of the center of gravity so that the forces acting upon them tend to force the boat down bodily on a level keel and they also lift the boat on a level keel With a horizontal rudder one must change the whole angle of the boat itself, while with the hydroplanes one instantly gets down pull or up pull.

Air is compressed in steel bottles Under the present government requirements all submarines must provide for a certain number of cubic feet of air up to as much as 2,500 pounds per square inch. The United States Government made a number of trials in 1907 in which the "Fulton and the Lake both remained submerged for a period of twenty-four hours Mr Lake had previously made experiments in 1897 to determine how long a crew could remain submerged living on air in the boat alone without drawing in an outside supply. The Argonaut was only 36 feet long and was for a period of five hours submerged without drawing on any air-supply from outside. Eight men at Newport in the 'Lake' remained for twenty hours under water without drawing on outside air, at the expiration of which time the air was getting a little thick and Mr Lake noticed that some of the men were losing interest in things about them. He had been observing the condition of the air by watching a lighted candle, measuring the height of the flame of the candle both at the top and at the bottom of the boat. In this way he could judge if carbonic acid gas was forming. He would repeat this test every hour, and after they had been submerged fifteen or sixteen hours he noticed that the flame began to diminish, which was the first indication of bad air. At the end of twenty hours it was impossible to keep the candle

[illegible]. About that time the men began to get sleepy and to breathe rather heavily; some fresh air was then admitted from the storage bottles The pumps were started and pumped the foul air out from the bottom of the compartment and the fresh air was admitted at the top; the candle flame then immediately brightened. They then remained for two hours longer, until the candle flame began to show signs of getting weak again, when they repeated the pumping operation and remained for another two hours and so on. When they came to the surface they immediately got under way and went back to Newport and none of the men suffered any bad effects

Boats have electric heaters and cooking is done with electric apparatus, the crew lives aboard some of the boats altogether

The French Government has been the most industrious in trying to use heavy oils for fuel for engines in fact, abroad a number of Continental firms have been experimenting with the Diesel engine and have met with considerable success within the last few years One government has proposed changing its gasoline engines for heavy oil engines so well was it satisfied with their performance Alcohol has not the same power as gasoline When one attempts to provide a fuel which reduces power and speed governments do not want it, so it looks as if the heavy oil engine is the solution of the problem Heavy oil engines are now so successful that Mr Lake proposes putting them in his future boats but he has never felt warranted in doing so heretofore

Compressed air is not carried in submarines for the sole purpose of providing air for the crew but for the purpose of handling water ballast discharging torpedoes and working certain machines. The Whitehead torpedo is discharged by compressed air

All of our boats are provided with a buoy which may be released to the surface The Russian buoy has information printed upon it in three languages English Swedish and Russian notifying the finders that there is a submarine boat below and asking them to open the buoy When one does so a telephone is found inside by means of which one can talk to the boat below There is a whistle on these buoys which is blown by compressed air and a light can be turned on at night they also have a tube by which the boat can be supplied with fresh air

Mr Lake knows of no practical method for vessels to protect themselves against submarines that has been proposed The putting out of booms he considers would be no defence at all because it would reduce the speed of the surface vessel using it The only protection vessels have to day against submarines is to get into a landlocked harbor and then have the harbor closed after them The putting out of booms and heavy chain netting would not assist them because their speed would be reduced so that the submarine could approach them at will and go under the chain if necessary or fire a succession of torpedoes and destroy the booms The only safety for the pursued vessel is to put out to sea and get away if she knows a submarine is below The torpedo will put any ship out of business and a submarine can approach any ship to-day The next war will without doubt prove that these little Davids are invincible

The British Government has made experiments exploding gun-cotton and found that an explosion 20 feet away from the vessel would do her no serious injury but an amount of gun-cotton exploded directly beneath a ship even at 100 feet depth would Mr Lake believes that a submarine would not be injured unless a mine were exploded right under her at a distance of 50 feet, it would not even rupture the hull

The best speed for submarines as far as Mr Lake knows is between 15 and 16 knots on the surface with gasoline engines He thinks that will be increased considerably within the next few years

Submarines are now built which have a submerged speed of 11 knots and this will also probably be increased

Mr Lake has made experiments and has kept the hair lines of the omniscope (which by means of direction indicating devices aims the torpedo) pointed right on the stem of a vessel for a period of as much as five minutes at a time that was actually done while a vessel was passing at a good rate of speed The man at the observing instrument can check on his hair lines and certain measuring devices the course of the vessel and correct the same The difficulty is will the torpedo run straight? Torpedoes are now made that will run up to 4 000 yards

Mr Leavitt who is the inventor of the torpedo of that name suggests that it might pay with torpedoes used by submarines to increase the charge of gun cotton and reduce the run Mr Leavitt sees no necessity for torpedoes which run over a thousand yards to be fired from submarines Of course when one fires at 4 000 yards the chances for making a hit are much decreased

Vanadium—Its Discovery and History

Found in a Brown Lead Ore from Zimapan, Mexico

In a formal communication dated at the city of Mexico on the second of the month Messidor in the ninth year of the French Republic Humboldt and Bompland first announced the discovery of the metallic element vanadium to the National Institute of France

The date given corresponds to the 21st day of June 1802 but the notice of the discovery was not published until 1804 when it was inserted in the Annals of the National Museum of Natural History

The discoverer of the new element was Manuel Del Rio Professor of Mineralogy in the city of Mexico He found it in a brown lead ore from Zimapan and after noting that it was different from chromium and uranium, called it erithronium because of the red color of its salts

In May 1803 or before Humboldt s letter to the French Institute was published there is an obvious reference to vanadium under the name of panchrome the article appearing in Spanish in the Annals de Ciencias Naturales and Del Rio being credited with the discovery of the substance

Humboldt together with his letter concerning erithronium sent to France samples of the brown mineral in which it had been found Collet Descostils an engineer in the Corps of Mines already known for his work on platinum and his reputed discovery of rhodium was entrusted with the analysis of the Mexican ores. His report was negative in reference to erithronium and concludes with the statement that the tests which he had made seemed sufficient to prove that these ores did not contain any new metal

Before he learned of the results of Collet Descostils s analyses and even before the announcement of his discovery had reached France, Del Rio changed his opinion and regarded erithronium (or panchrome) simply as a basic chromate of lead Writing on the lead minerals from the district of Zimapan he states

"From this brown lead ore I have extracted 14 80 per cent of a metal which at first seemed a new one and which I called panchrome because of the different colors presented by its oxides, its solutions and its precipitates, then I named it erithronium because it formed with alkalies and earths certain salts which became red under the action of heat and acids But having read in Fourcroy that chromic acid also furnishes red and yellow salts by evaporation I concluded that the brown lead ores were chromates of lead with an excess of base in the state of a yellow oxide Until the present, it has been regarded as a phosphate of lead."

Del Rio thinking that he had made a deeper study of the minerals, thus concluded that he had made an error in his first report, and he gives the result of his subsequent analysis of the lead ores as follows

"The brown lead mine contains 80 72 per cent yellow oxide of lead, and 14.80 per cent of chromic acid, the [illegible] per cent consists of arsenic, iron oxide and [illegible] acid."

[illegible] and erithronium, renounced by their discoverer [illegible] by an eminent French chemist were then forgotten and never entered the list of the chemical elements

More than a quarter of a century later in November 1830 Berzelius writes the following letter to Dulong

M Sefström director of the School of Mines of Fahlun on examining a piece of iron remarkable for its extreme softness has just recognized in it the presence of a substance of which the properties differ from those of all the elements known up to this time but the proportions of this substance are so small that it will require much time and expense to obtain a quantity sufficient for a thorough examination The iron comes from the mines of Taberg in Smaland the ores of which also contain traces of the new substance M Sefström having discovered that the pig iron contained a larger proportion of the substance than the iron refined therefrom concluded that the slags formed during the conversion of the pig iron into refined iron would be still more rich this conjecture was soon confirmed and M Sefström having thus succeeded in procuring a sufficient quantity of the new substance to enable him to study it came to me during the holiday vacation to finish his researches on the subject

Sefstrom after many experiments on the Taberg irons applied himself to studying the characteristic reactions of the new element and to marking the distinctions between it and chromium and uranium both of which metals exhibited many analogies The result was that with only two decigrammes of material to work upon he established the existence of the new element beyond question He recognized its several degrees of oxidation and even described some of its salts

Taking up his researches again in the autumn of 1830 at Fahlun, in the laboratory of Berzelius, he succeeded in extracting further quantities of the new element from furnace slags indicated his method of recovering it and named it vanadium from Freya Vanadis, the principal goddess of Scandinavian mythology

Hidden in the earth since time began suspected for thirty years and then conclusively recognized vanadium thus took its place among the elements in the year 1830

Berzelius, in his communication to the Annales de Chimie et de Physique credits Sefström with the discovery of vanadium gives the result of his researches and commends him for his success in overcoming unusual difficulties

Berzelius then endeavored to isolate the metal but failed Attempting to reduce the oxides by carbon and by hydrogen he obtained in both cases only a lower oxide with a somewhat metallic luster Using potassium, he obtained a grayish powder which gave a metallic luster when polished He then heated vanadium chloride in a current of dry ammonium gas and produced a compound with a brilliant metallic luster but which Schafarick proved was only the nitride of vanadium.

Johnson, Crudnowiez, Rammelsberg and Schabus continued the work on vanadium and without isolating it succeeded in fixing its classification in the system of elements

Sefstrom had found vanadium in iron ores other than those of Taberg Kersten found it in 1841 in the copper schists of Mansfield and Thuringia Woehler discovered it in the pitchblend of Joachimsthal now so famous on account of its radio-active elements But in none of these cases did the vanadium content run higher than one tenth of one per cent and the combinations made by the metal remained undetermined No industrial application had been found for it and its detection in widely scattered localities was simply a matter of chance

In 1859 H St Claire Deville sent a note to the Academy of Sciences and indicated the presence of considerable quantities of vanadium in a ferruginous aluminium deposit at Baux between Arles and Toulon

About this time vanadium was discovered in many kinds of clay throughout France Terrell found it in some Sevres pottery but in very small quantities

St Claire Deville suggested the first industrial application of vanadium as a coloring agent in ceramics He also prophesied its larger employment in metallurgy after noting the improvement in some cast iron that showed the presence of vanadium

Commercial caustic soda and potash usually contain vanadium sulfide of sodium even the purest kind always presents a slight yellowish tinge due perhaps to traces of vanadium Roscoe found it in 1867 in the copper deposits of Cheshire England Witz and Osmond found it in the basic slags from the Creusot furnaces in which the oolithic ores of Mazenay were used the quantity rising as high as one per cent This vanadium was used exclusively in the manufacture of aniline black because of its powerful oxidizing properties

Vanadium exists in considerable quantities in the oils and anthracites of South America and is found in the titaniferous iron ores of the Adirondacks It has been found in meteors and exists in some stars and the sun

Sir Henry Roscoe isolated it in the metallic form in 1867 Moissan made cast vanadium in the electric furnace in 1894 Helouis developed a commercial process for the preparation of vanadic acid in 1896 and produced in the same year alloys of vanadium and iron by the alumino-thermic process

Electric traction matters are very active in the Pyrenees region of France About 200 miles of standard gage road will be equipped by the South Railroad Company from Bayonne to Toulouse The work will be started with the 65-mile section between Montrejeau and Pau For this thirty motor cars have already been ordered, and they will take 100 ton passenger trains. On this line the single phase 300-volt system will be used The company is taking steps to erect these hydraulic plants in the mountain region to secure the current.

Experimental Science Teaching

Some Applications of Mariotte's Bottle

The apparatus known as Mariotte's bottle consists in its simplest form of a half gallon or gallon bottle (*A* in Fig 2) having a horizontal outlet tube near its bottom and a vertical tube which passes through a cork into the neck and extends inside the bottle to any desired level higher than the lateral outlet. When the bottle is filled with water and the outlet is opened air enters in bubbles through the vertical tube and water flows from the outlet in a stream of constant velocity as long as the level of the water in the bottle is higher than the bottom of the vertical tube because in these conditions the effective head of water that determines the flow is the height of the bottom of the air tube above the outlet no matter what the actual level of the surface of the water in the bottle may be. Mariotte's bottle therefore affords a convenient means of obtaining a steady and uniform flow of water and it is for this purpose that it is employed in the experiments here described.

Intermittent Springs.—The action of natural intermittent springs of water may be illustrated and imitated by means of the Mariotte's bottle in conjunction with the toy called the vase of Tantalus which is shown at *D* in Fig 2. The vase of Tantalus is a vase or jar the bottom of which is traversed by a tube having both ends open and the upper end bent downward to form a siphon. It easily can be

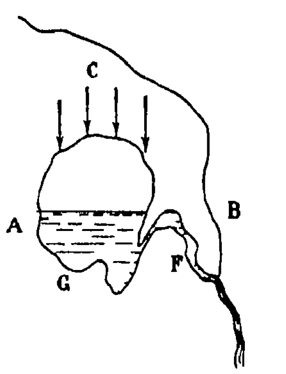


Fig 1.—Natural Intermittent Spring

made at home by fitting a cork to a hole cut in the bottom of a tin pail or biscuit box and fitting to a hole bored in the cork a glass or rubber tube bent to the required form as is shown in the right hand illustration of Fig 2 where *E* is the pail or box and *F* the tube. The left hand illustration shows the conventional vase of Tantalus arranged in combination with a Mariotte's bottle to imitate the action of an intermittent spring. The Mariotte's bottle *A* placed on a high support *C* discharges through its outlet *B* a constant stream of water into the vase of Tantalus *D* which is placed on a lower support *C*. The water cannot escape from the vase of Tantalus until it has risen to the top of the siphon *F*. It will then begin to flow out through the siphon into the vessel *G* beneath and it will continue to flow until the level of the water in the vase has fallen to the level

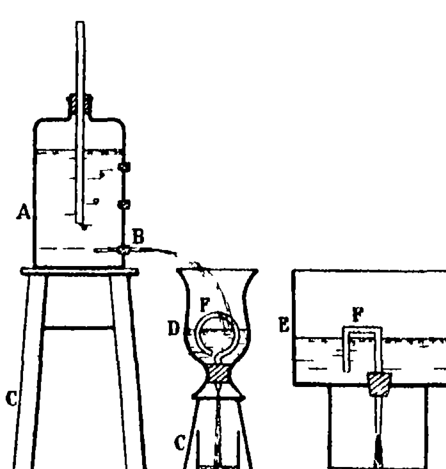


Fig 2.—Artificial Intermittent Spring

of the mouth of the siphon. The flow from the vase of Tantalus will then stop but it will recommence when the water level in the vase has again been raised to the bend of the siphon by the constant inflow from the Mariotte's bottle. With a siphon of large bore combined with a small outlet and low head of water in the Mariotte's bottle the water will escape in sudden gushes at considerable intervals from the vase into which it is slowly and steadily trickling from the bottle. The action of a natural intermittent spring is quite analogous to this. The spring is the outlet of a natural fissure *F* (Fig 1) having the form of a siphon and communicating with a cavity *G* into which water slowly percolates as is indicated by the arrows *C*. When the water attains

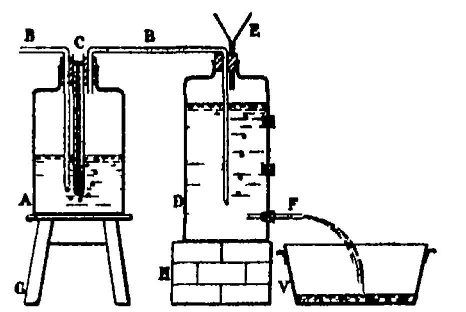


Fig 3.—Cooling and Freezing Water

the level *AB* a large quantity is rapidly discharged and the spring then ceases flowing until the water level has again been raised to *AB* by infiltration.

Cooling and Freezing Water.—Half fill with ether a wide mouthed bottle *A* (Fig 3) and fit to holes bored in the cork two bent glass tubes *BB* and a test tube *C* containing water and a thermometer. One of the bent tubes *B* dips into the ether and its upper end communicates with the atmosphere. The other tube *B* extends only a little below the cork and is connected with the air tube of a Mariotte's bottle *D* which is filled with water and has a large outlet *F* closed by a cork. The height of the thermometer is noted and the cork is removed from the outlet of the Mariotte's bottle which acts as an aspirator and draws a current of air through the tubes *BB* and the ether in the bottle *A*. The rapid evaporation of ether thus caused produces a correspondingly rapid lowering of the temperature of the water in the test tube which is soon cooled to the freezing point if the air of the

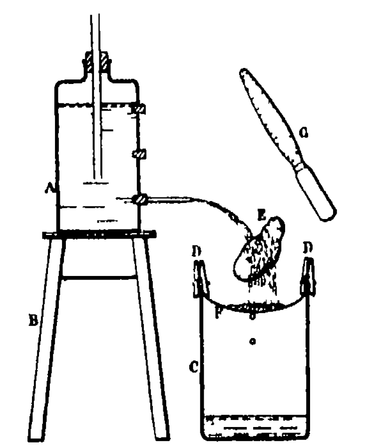


Fig 4.—Analysis of Potatoes and Flour

room is moderately cool. In order to freeze the water however the Mariotte's bottle must be refilled two or three times and the flow quickly re-established. Time can be saved by providing the Mariotte's bottle with a funnel *E*. This experiment illustrates the method of cooling and making ice by the evaporation of liquefied ammonia and other gases.

Analysis of Potatoes and Flour.—Fig 4 illustrates the use of a Mariotte's bottle in separating the starch from potatoes. The peeled potato *F* is rasped with the rasp *G* under the stream of water issuing from the tapered outlet *H* of the Mariotte's bottle *A* and over a piece of muslin *F* fastened by spring clips *DD* to the rim of a deep vessel *C*. The broken starch cells consisting chiefly of cellulose, are retained by the cloth while the starch and water pass through. The starch grains slowly settle to the bottom of the vessel *C*. The water is then decanted and the wet starch is dried on a surface of plaster of Paris. Flour is analysed by kneading it with the hand under the jet of water which carries the starch into the receiving vessel while the gluten remains as a plastic mass in the hand.

Cooling Laboratory Distilling Apparatus.—Fig 5 shows a Bunsen burner *F* heating a retort *A* of which the neck *B* enters that of a receiver *C* which is cooled by a stream of water from a Mariotte's bottle *E*.

Cooling Woolf Bottles, Etc.—A Woolf bottle is a bottle with three necks which is used in preparing solutions of ammonia and other gases. In many cases continuous refrigeration of the apparatus is necessary. For this purpose a Mariotte's bottle filled with cold water may be employed, in the manner shown in Fig 6. The Woolf bottle *A* contains water in which gaseous ammonia, flowing in through the left hand tube *B* to the bottom of the vessel is being dissolved while any excess of gas escapes through the right hand tube *B* to a second Woolf bottle (not shown). *C* is a safety tube which by admitting air prevents the pressure in the space above the liquid from falling low enough to cause an influx of liquid from the second bottle. The Woolf bottle pictured stands in a vessel filled with cold water which is frequently or continually replenished by means of the funnel *F* and the Mariotte's bottle *M* while the uppermost and warmest stratum flows off through the outlet *G* to the vessel *R*.—La Science XXme Siècle.

Inheritance of Acquired Characters

In the Scientific American Supplement early in 1910 there appeared an account of some experiments by Dr Paul Kammerer of Vienna wherein the amount and distribution of pigment in the skin of certain lizards was modified by the conditions under which they were kept and these modified patterns were reproduced in the offspring kept under normal conditions.

Dr Kammerer has been continuing his experiments with lizards and reported some further results at

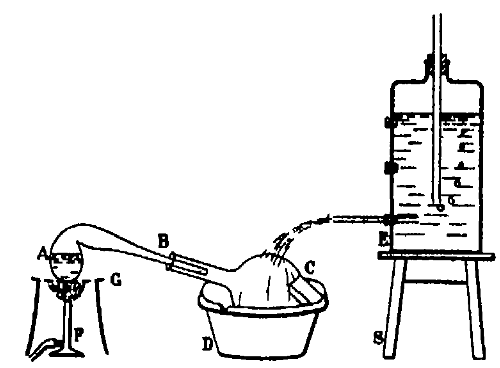


Fig 5.—Cooling Receiver of Retort

the International Physiological Congress held in Vienna this fall.

In the first series of experiments the modifications produced were in the reproduction of the animals. *Lacerta vivipara* instead of laying eggs like the other members of the genus bears its young ready formed. A number of these animals were kept in a warm chamber—25 deg to 30 deg C.—and these laid eggs which afterward hatched out. The first batch of eggs laid were without shells the later batches had parchment like shells resembling those of other species that normally lay eggs. A species that bears young was there modified by the temperature into one that bears eggs. The lizards that hatched from these eggs were placed in chambers of normal temperature here instead of reproducing by bearing young as we should expect according to the prevailing biological theories the females laid eggs again. Here then there appears to be a transmission to the offspring of a modification induced in the parents.

Another experiment was conducted with specimens of *Lacerta serpa*, which normally lays eggs with a soft shell. On keeping these in a warm room—30 deg to 35 deg C.—the later eggs were found to have

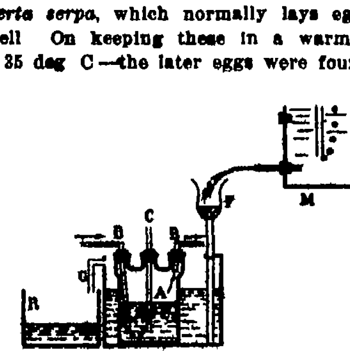


Fig 6.—Cooling Woolf Bottles

rather hard shells. The lizards that hatched out of these eggs were kept at normal temperatures but when they reproduced, their eggs were provided with the hard shells. Again there seems to be the transmission of a character that was acquired during the lifetime of the parent as a result of the action of some external factor.

The other experiments had to do with the modification of colors by increase in temperature, and were similar in their results to those already described in the article referred to.

Magnetic Crystals

An Interesting Investigation Into the Magnetic Properties of Crystals

By Dr Victor Quittner

STRICTLY speaking, crystal magnetism is the oldest part of the entire subject of magnetism for magnetite, lodestone or magnetic iron ore which crystallizes in beautiful octohedra and rhombic dodecahedra is the substance in which the phenomena of magnetism were first observed by the Greeks After a method had been discovered of making steel magnets very much stronger than natural magnets the latter lost their practical importance and no further attention was paid to them For centuries magnetic observations were confined to iron which was regarded as the only magnetic substance

In 1845 Faraday discovered that all substances without exception possess magnetic properties generally however to so slight a degree that the most delicate instruments are required for their detection Substances are divided into two classes paramagnetic substances which are attracted by both poles of a magnet, and diamagnetic substances which are repelled by both poles Both attraction and repulsion are produced by the magnetization of the body by the external magnetic field When a paramagnetic body is placed between the poles of a powerful magnet a south pole is developed in the body opposite the north pole of the magnet and conversely As each of these induced poles is of opposite sign to the pole of the strong magnet which is nearest to it the body is

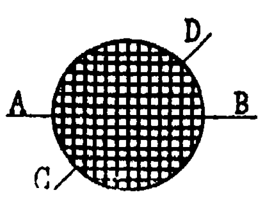


Fig 1 Grating of Iron Wires representing Plate cut from a Crystal of Magnetite

attracted by both poles of the magnet When a diamagnetic body is placed between the poles of a strong magnet a north pole is developed opposite the north pole of the magnet and a south pole opposite the south pole Hence the body is repelled by both poles of the magnet The results may be expressed by saying that in paramagnetic substances the magnetization and the external field have the same direction but in paramagnetic substances their directions are opposite

A special class of paramagnetic substances which are attracted very strongly by magnets are called ferromagnetic Only six such substances are known 1 iron in all of its modifications 2 nickel 3 cobalt 4 magnetite or lodestone 5 magnetic pyrites ($Fe_7 S_8$) also called pyrrhotin 6 the magnetic alloys of copper manganese and aluminium which were discovered by Heusler a few years ago In a field of given strength ferromagnetic bodies acquire a magnetization millions of times stronger than that of ordinary paramagnetic and diamagnetic substances and they also show many other peculiarities which warrant their segregation in a special class One of these peculiarities is their behavior in fields of different strengths In paramagnetic and diamagnetic bodies the magnetization is simply proportional to the strength of the external field up to the strongest

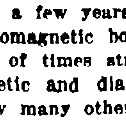


Fig 2 —Arrangement of Molecules in Magnetite

fields that can be produced (46 000 gauss) In ferromagnetic bodies this proportionality holds only in very weak fields (less than one gauss) As the strength of the field increases the magnetization increases also but less rapidly until with a field of 1 000 to 3 000 gauss the magnetization attains a limit beyond which it cannot be increased by increasing the strength of the field This condition is called magnetic saturation Another peculiarity of ferromagnetic bodies, called hysteresis consists in their consumption of energy and its transformation into heat when their magnetization is repeatedly and rapidly reversed Probably paramagnetic bodies would exhibit the same property in fields of several million gauss but such fields cannot be produced

To return to magnetic crystals. All crystals may be regarded as magnetic, for every crystal, like every other body, is either paramagnetic or diamagnetic or ferromagnetic.

The extensive researches of Plücker and Faraday proved that the magnetic phenomena of crystals differ from those of other bodies If a sphere of an uncrystallized or isotropic substance is placed in a uniform magnetic field it remains in equilibrium in any position But a sphere of calc spar for example placed in the same field turns so that its principal crystal

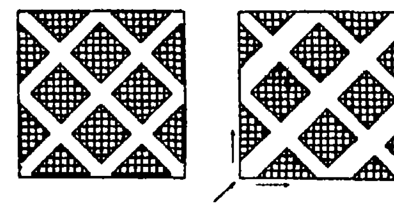


Fig 3 —Effect of Fissures in Magnetite

lographic axis is perpendicular to the lines of magnetic force Diamagnetic crystals of antimony and paramagnetic crystals of tourmaline beryl etc behave like the diamagnetic crystals of calc spar Other crystals including those of bismuth arsenic and zirconium (diamagnetic) spathic iron ore and uranium mica (paramagnetic) place themselves with the principal crystallographic axis parallel to the lines of force The phenomena vary greatly with the different crystalline systems Faraday was unable to explain them otherwise than by the assumption of a peculiar force which he called magne crystallic force This was no explanation but only the invention of a name

A real theory of crystal magnetism which explains the apparently very complicated phenomena in an exceedingly simple manner was devised a few years later by Sir William Thomson (Lord Kelvin) I will attempt to present this theory in an easily intelligible form

In every crystal and in every anisotropic body in general there are three special directions which are called magnetic axes When the crystal is placed in a magnetic field with any of its axes parallel to the lines of force it behaves like an isotropic body i e it acquires a magnetization (para or dia) in the common direction of that axis and the field If this experiment is repeated with each of the three axes suc

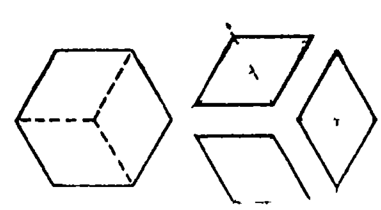


Fig 4 —Hexagon Composed of Three Rhombs

cessively parallel to the lines of force it is found that a field of given strength produces different degrees of magnetism in the three cases Phenomena of very different character are exhibited when the axes are inclined to the magnetic field In this case the axis along which the strongest magnetization can be produced draws so to speak the magnetization to itself so that the direction of magnetization within the crystal is intermediate between this axis and the direction of the field Consequently the crystal turns and continues turning until the axis of greatest magnetic permeability that is the axis along which the strongest magnetization can be produced is parallel with the lines of force If the crystal is diamagnetic the result is similar but in the final position of the crystal the axis of least magnetic permeability is parallel to the lines of force In these experiments it is assumed that spheres or disks cut from the crystals are employed as otherwise the position may be modified by the form of the body

Thomson's theory gives a qualitative and quantitative explanation of all the phenomena observed in paramagnetic and diamagnetic crystals It makes the assumption of any special force unnecessary so that Faraday's magne-crystallic force has disappeared from the text books This theory also makes it possible to deduce the magnetic properties of a substance from its crystalline form

There are six fundamental systems of crystallization 1 regular or tesseral 2 quadratic or tetragonal 3 hexagonal 4 rhombic 5, monoclinic and 6 triclinic or unsymmetrical From everything that we know of the other physical properties of crystals we should expect their magnetic properties to exhibit the same variety of symmetry that is shown by their crystalline structure. In the regular system, in which the three principal axes of crystallization are identical in every respect we should expect the three principal magnetic axes which coincide with the crystallographic axes to exhibit equal capacities for magnetization But if this is the case the direction of magnetization in any position of the crystal must coincide with the direction of the external magnetic force and the crystal must behave in the magnetic field exactly like an isotropic or uncrystallized substance We shall see later that this is not quite true in the case of ferromagnetic crystals of the regular system Crystals of the tetragonal system have one principal axis and two or three secondary axes lying in a plane perpendicular to the principal axis In this plane the crystal acts as an isotropic body as the secondary axes are entirely similar to each other According as the principal axis is more or less magnetisable than the secondary axes and according as the crystal is paramagnetic or diamagnetic it places itself with the principal axis in the direction of the magnetic field or perpendicular thereto In crystals of the rhombic monoclinic and triclinic systems there are three magnetic axes of unequal permeability which coincide with the crystallographic axes only in the rhombic system The crystal if paramagnetic places itself with the axis of greatest permeability in the direction of the field

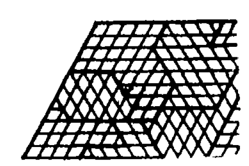


Fig 5 —Arrangement of Elementary Rhombic Crystals in Pyrrhotin

if diamagnetic with the axis of least permeability in that direction The following table gives the above mentioned facts at a glance

Paramagnetic and Diamagnetic Crystals

Crystalline System	Magnetic Properties.
Uncrystallized Regular	3 equal magnetic axes Isotropic in all directions
Tetragonal Hexagonal	3 magnetic axes only two of which are equal Isotropic in the plane of these axes which is perpendicular to the third or principal axis
Rhombic Monoclinic Triclinic	3 unequal magnetic axes Anisotropic in all directions

For many years Thomson's theory comprised our entire knowledge of the magnetic properties of crystals and it was generally believed that the theory applied to all crystals including those of ferromagnetic substances of which no exact studies had been made

Our knowledge of the properties of ferromagnetic crystals are due entirely to the researches of Prof

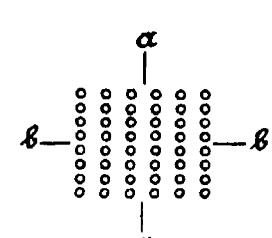


Fig 6 Arrangement of Molecules in Pyrrhotin

Pierre Weiss of Zurich and his pupils of whom the writer of this article was one The researches were not undertaken solely with the view of exploring this very small field but especially for the purpose of affording a basis for a theory of the very incompletely known and understood properties of iron and other ferromagnetic substances for all strongly magnetic substances are composed of microscopic crystals It seemed probable that a single crystal possesses properties of simpler character than those of the mass and that when the properties of the elementary crystals had been determined it would not be difficult to calculate those of the mixture of crystals which constitutes the apparently isotropic ferromagnetic substance.

The experiments were conducted chiefly with crystals of magnetite and pyrrhotin also with small crystals of metallic iron which are occasionally found in

old railway rails and in iron manufactured by Goldschmidt's thermite process These crystals of iron are never larger than a few millimeters and are consequently too small for exact measurements but magnetite and pyrrhotin occur in fine large crystals Magnetite chemically an oxide of the formula Fe_3O_4 crystallizes in the regular system forming octohedra and rhombic dodecahedra some of which are four inches in length Pyrrhotin is a sulphide which contains from 36 to 39 per cent of sulphur corresponding approximately to the formula Fe_7S_8 or Fe_8S_9 It crystallizes in hexagonal pyramids and prisms belonging to the hexagonal system Metallic iron crystallizes in small cubes belonging to the regular system In some of the experiments the substances were employed in the form of small rods but they were more generally used in the form of thin plates cut from the crystals in various directions The diameters of the plates ranged from 1/2 inch to 4/5 inch according to the size of the crystals Only the larger plates could be employed for exact measurements Very great importance was attached to having the plates perfectly circular and of uniform thickness throughout hence very great care was ta[illegible] oduction Because of their fragility they were cemented to glass plates with Canada balsam and cover glasses were fastened over them

A detailed description of the experiments and measurements would necessarily be too technical to have general interest I will merely mention that two general methods were employed In one the crystal plate was suspended in a horizontal position between the poles of a magnet and the force with which the external magnetic field turned the plate was measured by the torsion of a spiral spring by which the plate was suspended In the other method a galvanometer was employed to measure the current induced in a coil of wire when the magnetized crystal plate was inserted in the coil The results obtained by the two methods always agreed very closely The first experiments the results of which were published in 1896 related to magnetite Considerable surprise was created by the discovery that magnetite although perfectly regular in crystalline form does not behave like an isotropic substance in the magnetic field Upon a little consideration however this result does not appear so surprising for Thomson's theory is based upon the assumption that although the magnetization of a crystal may be unequal in different directions it is in each direction proportional to the intensity of the field We have already stated that although this law is obeyed perfectly (at least with any strength of field that we can produce) by diamagnetic and ordinary paramagnetic bodies it is not obeyed by ferromagnetic substances either isotropic or crystallized

Hence Thomson's theory does not apply to ferromagnetic crystals and the conclusions drawn from this theory with regard to the magnetic behavior of crystals of the regular system do not hold in the case of ferromagnetic substances When a plate of magnetite cut perpendicular to any one of the crystallographic axes was placed in a weak magnetic field (31 5 gauss) it appeared perfectly isotropic but when the strength of the field was increased the magnetization in the direction of either axis was found to be much smaller than the magnetization in a diagonal direction When however the strength of the field was still further increased this difference gradually disappeared until with a field of 1 000 gauss the magnetization became equal in all directions and attained its maximum or saturation value of 482 magnetic units The limit of saturation of good wrought iron is 1750 Hence the magnetic capacity of magnetite is 3 6 times less than that of soft iron and nearly equal to that of nickel (490)

How can these phenomena be explained? Let us suppose that the crystal is composed of a framework of iron wires one third of which run parallel to each of the three axes A plate cut from such a crystal at right angles to any axis would present the appearance shown of a rectangular network of wires (Fig 1) When such a plate is magnetized in the direction of the axis *AB* the magnetic force unless it is extremely strong exerts an appreciable magnetizing effect only upon the wires which are parallel to *AB* as it is very difficult to magnetize a thin wire transversely Hence the magnetization affects only one-half of the wires of which the plate is composed If on the other hand the magnetic lines of force run in the direction of the diagonal *CD* both the wires parallel to *AB* and the wires at right angles to *AB* become magnetized In this case only a component of the magnetic field acts upon each group of wires but as each component exceeds 70 per cent of the entire strength of the field the total magnetization produced is greater than in the former case in which the field was parallel to the axis It can be computed that this difference begins to manifest itself when the strength of the field is about 40 gauss The vanishing of the difference in very strong fields is explained by the fact that in such fields even the wires which run transversely are magnetized to saturation.

Prof Weiss has proved the general correctness of this explanation by constructing such an artificial plate of fine iron wires and showing that its magnetic behavior is identical with that of the plate cut from the crystal of magnetite. Of course we are not to regard the crystal as being really composed of iron wires The same results would follow if the molecules were arranged in strings like beads, and these strings were stretched in the directions of the three axes (Fig 2) Here the molecules form the apices of small cubes and the structure is called a cubical spatial arrangement or space grating' (Raumgitter) Hence the magnetic properties of magnetite bring us back to the old space grating theory which has long been used for the explanation of other properties of crystals

In the more exact investigation of magnetite which was undertaken by the writer in connection with these first experiments other very remarkable phenomena were discovered in some plates cut perpendicular to the axes of magnetite crystals In the weakest field of 31 5 gauss the magnetization was stronger along one diagonal and weaker along the other than along the axes As the strength of the field was increased the magnetization along the weaker diagonal increased rapidly attaining the value of the axial magnetization with a field of 63 gauss As the strength of the field was further increased the phenomena approached more and more closely to those of the typical plates first described

How can we explain these remarkable results? Shall we assume that magnetite which has always been regarded as a typical representative of the regular system of crystallization belongs to that system only in appearance? After very thorough investigation I concluded that magnetite does crystallize regularly and that the results above observed are secondary phenomena caused by fissures in the substance of the crystal I picture the crystal crossed by numerous narrow fissures parallel to each face of the octohedron If the fissures in the various directions are equal in width a plate cut perpendicular to the axis would be represented by the left hand drawing of Fig 3 In this case the fissures diminish the magnetization only slightly and to practically the same extent in every direction If on the contrary the fissures in one plane are wider than those in another a plate cut perpendicular to the axis will be represented by the right hand drawing of Fig 3 Here it is evident that the fissures will diminish the magnetization along one diagonal more than that along the other and that the magnetizations in the directions of the two axes will be equal to each other Increase in the strength of the field will diminish all of these differences

Hence we see that the study of the magnetic properties of crystals gives an interesting insight into crystalline structure The results thus obtained have been confirmed in many instances by observations in other fields of crystallography For example the presence of the fissures mentioned above is indicated by the fact that the cleavage planes of magnetite are parallel with the faces of the octohedron A second proof is furnished by the fact that the octohedral crystals have perfectly smooth and glossy faces but the rhombic dodecahedra always show distinct stripes running parallel with the longer diagonal of the rhomb These stripes are the intersections of the internal fissures with the faces of the crystal

Still more interesting results were obtained with pyrrhotin It was discovered at the outset that pyrrhotin which crystallizes in hexagonal prisms is scarcely susceptible of magnetization along its principal axis The magnetization in this direction is a thousand times less than in the plane at right angles to this axis which may be called the magnetic plane The three secondary crystallographic axes, which lie in the magnetic plane are found to be magnetically unlike The phenomena appear entirely irregular In one plate the greatest magnetic permeability is shown by one axis in another plate from the same crystal by another axis etc Here therefore we have again an apparent deviation from symmetry with the crystalline form But while in the case of magnetite the deviation is only apparent in pyrrhotin it is real The real magnetic properties of pyrrhotin are intelligible only upon the assumption that the crystal, apparently a hexagonal prism is really a conglomerate of elementary rhombic prisms placed in three different positions (Fig 4) We are not to suppose that the crystal is made up of three rhombic prisms, but that it is composed of minute rhombic prisms mingled in an irregular manner, so that one type preponderates in one part a second in another, etc. (Fig 5)

An attempt was made to isolate one of these elementary crystals A crystal which showed a marked preponderance of one of the three elements was cut in two, one of the pieces which showed this preponderance to a still greater degree was again divided and this process was repeated until a number of very small fragments [illegible] was composed almost entirely of a single elementary crystal.

When a plate cut parallel to the magnetic plane of such an elementary crystal was examined it was found that magnetic saturation along one diagonal of the rhomb was produced by a field of a few hundred gauss, while in the perpendicular direction saturation was not complete with a field of 11,000 gauss. For the sake of completeness it may be added that in the direction of the principal axis perpendicular to the magnetic plane more than 200 000 gauss would be required to produce magnetic saturation. The limit of saturation of pyrrhotin is 47 units, about one-tenth that of magnetite and one-thirtieth that of soft iron

These peculiarities of the elementary crystals can be explained by the simple assumption that the molecules are arranged according to a rectangular plan, but at unequal intervals along the three axes, so that they form long rectangular parallelepipeds. (Fig. 6.) It is evident that the magnetic strength would be greater in the direction of *aa*, in which the molecules are nearer together than in the direction of *bb*

In the elementary crystal of pyrrhotin saturation in one direction is produced by a very weak magnetic field When we consider that the fragments examined were very small and always contained some admixture of the elementary crystals of the other two types we may be forced to conclude that, except for these obstacles saturation would have been obtained with a still weaker field Hence Prof Weiss makes the bold conjecture that the elementary crystals of pyrrhotin are always, even in the absence of external magnetic force magnetized to saturation in the direction of maximum permeability This assumption is in harmony with Weiss's electronic theory of ferromagnetism, according to which magnetic saturation in one direction always exists in ferromagnetic substances

This condition of magnetic saturation is not observed in larger fragments of pyrrhotin which contain crystals of all three types so mingled that they almost neutralize each other When the large crystal is placed in a magnetic field the magnetization of the elementary crystals cannot be increased as these are already in the condition of saturation but these crystals are turned more or less and the strength of the magnetization in the direction of the field depends upon the amount of this action

Weiss's theory is not a vague speculation but is supported by many exact measurements of the amount of hysteresis the angle between the field and the induced magnetization etc We are tempted to extend to ferromagnetic substances in general the structure which appears to be possessed by pyrrhotin We may regard each of the small crystals of which iron is composed to be always magnetized to saturation As these crystals lie in all directions they neutralize each other unless they are turned by an external magnetic field so that their magnetic axes become approximately parallel

Hence we see that the study of the apparently recondite field of crystal magnetism on the one hand gives an interesting insight into the structure of ferromagnetic crystals (which can be extended by analogy to other crystals) and on the other hand suggests many valuable inferences concerning the nature of ferromagnetism and magnetism in general. —Prometheus

Chemical Misnomers

The word 'oil' in its more comprehensive and everyday use is made to include hydrocarbons, like petroleum and also many substances that have an oily appearance, such as 'oil of vitriol,' which is not oil at all but sulphuric acid Strictly speaking the mineral oils including all petroleum products, are not oil although we speak of "coal oil" and "kerosene oil," and the companies that supply us with those products are called 'oil companies.

The highest authorities do not include in their lists of oils the mineral hydrocarbons like naphtha, paraffin and petroleum but treat only the two well-defined groups—fixed oils and fats, and the essential or volatile oils

'Copperas" is a conspicuous example of chemical misnomer It is not copper, but sulphate of iron. 'Salt of lemon" has nothing whatever to do with the fruit of the lemon-tree, but is potassium binoxalate, or potash treated with oxalic acid.

Carbolic acid" is no acid, but a phenol In structure it is allied to the alcohols, and has only slight acid properties. "Soda-water" shows no trace of soda; "sulphuric ether" contains no sulphur, and "sugar of lead" is entirely innocent of sugar "Cream of tartar" has no cream, nor "milk of lime" any milk. "German silver" is not silver at all, and "black lead" is graphite, not lead, "Mosaic gold" is a sulphide of tin.

These misleading names have come down to us from the vocabulary of an early and [illegible] chemistry. The popular [illegible] the old terms [illegible] the more scientific nomenclature.

Power Production from Solar Radiation*

A Plan for the Exploitation of Natural Sources of Power

By R. A. Fessenden

The problem of the commercial utilization for the production of power of the energy of solar radiation the wind and other intermittent natural sources is a double one The energy of the sources must first be changed so as to be available in form it must next be stored so as to be available in time

As regards the second of these two points one of the expedients which perhaps naturally suggests itself, namely the use of storage batteries is commercially quite out of the question owing to its high cost The method actually employed is storage by gravity Two reservoirs are constructed one at a considerably higher level than the other and the water is first pumped up and then allowed to fall as desired and to actuate a turbine A cubic yard of water falling through one thousand feet is capable of giving out energy equivalent to one horse-power hour If we consider the possible plans for carrying out this project the arrangement which perhaps first occurs to us is that of building a tank at the top of a tower But this is impracticable for either the volume of water required is excessive or else the height of the tower becomes prohibitive The problem assumes more promising form if the upper tank is built on the level of the ground and the lower tank at the bottom of a deep shaft Estimates were obtained from three different firms of mining engineers in Philadelphia which showed that a shaft one thousand feet deep could be dug properly timbered and the necessary chambers hollowed out at the bottom and ferro concreted so as to withstand the water pressure at a cost not to exceed two dollars per cubic yard Assuming two weeks storage and an efficiency of 75 per cent the capital cost per horse-power will be $37 50 Assuming interest at four per cent and depreciation at two per cent the annual cost of water storage facilities exclusive of the pumps and turbines will therefore be approximately $2 25 per horse power

Tenders for the pumps and Pelton turbine wheels for a 3 000 horse-power plant show that the cost of these is approximately $12 50 per horse power Allowing four per cent interest and four per cent depreciation this makes a total annual cost for pumps and turbines of one dollar per horse power The total annual cost of storing one horse-power by the negative gravitational method is therefore $1 00 + $2 25 = $3 25

As regards efficiency water storage has the advantage over the electric accumulator The energy efficiency of a storage battery is generally given as about 65 per cent i e approximately 80 per cent on charge and 80 per cent on discharge

With water storage it is safe to assume an energy efficiency of 89 per cent both at charge and discharge giving a net efficiency of 80 per cent

We have next to consider the method of obtaining the energy from the sources There are two main sources available solar radiation and the wind

To obtain an idea of the amount of power which solar radiation represents under normal working conditions a long-continued series of measurements were made by Prof Very who found that the amount of solar energy received per annum at the earth's surface on an area one hundred meters square in the places indicated is on an average as follows

	Kilowatt hours
Central Europe	4 000,000 to 6 000 000
Northern United States	5 000 000 to 7 500 000
Southwestern United States	10 000 000 to 15 000 000

As regards the amount of power to be derived from the wind tests made during a period of one year on a steel tower 420 feet high at Brant Rock Mass showed an average of 800 horse power at the shaft of a windmill of 300 feet equivalent diameter These figures are about 30 per cent higher than those obtained by Danish experimenters the difference is probably to be attributed to the fact that the Danish experiments were made near the surface of the ground

To utilize solar radiation it is proposed to use a solar tank containing water heated to about 100 deg C* The steam so generated at atmospheric pressure is to drive a low pressure steam turbine which operates the pump Low pressure working is resorted to because with this arrangement the transparent top of the chamber containing the working fluid can be made very thin and has to withstand practically no pressure The transparent roof is designed of double thickness and contains wire netting imbedded in the glass as a protection against hail The working fluid flows in a thin stream across the bottom of the solar tank and the thickness of the stream is varied automatically with the amount of radiation received

The working fluid contains a small amount of potassium dichromate The glass forming the transparent covering contains a small amount of sulphate of iron sufficient to give it a pronounced greenish tinge It has been found that by this means the glass can be made totally reflecting for wave lengths corresponding approximately to those emitted by the heat of water while remaining fairly transparent to the radiation from the sun The thermodynamic efficiency of the system is approximately fifteen per cent and it is anticipated that about ten per cent would be obtainable on the shaft of the steam turbine

From tenders made the costs per horse power have been found approximately as follows

Solar tank	$10
Low pressure steam turbine and condenser	$2[illegible]
Dynamo	$15

Adding to this the cost of the pumps and the water turbine we obtain a total of $62 50 for the first cost per horse-power for the machinery exclusive of the reservoirs Allowing interest at four per cent and depreciation at four per cent and two per cent for labor we obtain a value of $6 25 per annum per horse power as the cost exclusive of the reservoirs Adding in the cost of the reservoirs we find $8 50 as the actual cost per horse power

It will be seen that these figures compare favorably with the present cost of producing power from coal Moreover these estimates are excessive for the reason that it is proposed to operate a windmill plant in conjunction with each solar radiation plant The load will thus be greatly evened and a much better all-day and all year efficiency obtained because the wind is as a rule more effective during cloudy weather and at night time i e at the time when solar radiation is diminished or absent The storage reservoirs employed in connection with this solar plant are of course available without additional cost for the wind power installation

Assuming a solar tank 200 meters square we may expect to receive a total radiation of approximately twenty million kilowatt hours per annum Assuming an efficiency of ten per cent we should get two million kilowatt hours at the steam turbine shaft On the basis of a seven hour day the solar radiation plant would yield an average of 800 horse-power Adding to this the energy derived from the windmill we obtain a total of about 1 500 horse power

The figures given above are for average conditions The location of the first plant is on the whole much more favorable It is situated at a copper mine where the vertical shaft is already available and where worked out lateral chambers are used for the lower reservoir A portion of the pumping machinery also is provided at the mine thus further reducing the cost of installation

The following is a comparative estimate of the costs of producing one horse power for one year by steam gas engine water power at Niagara Falls and the present method The estimates are based on a plant having a capacity of 100 000 horse power operating under average conditions

Method of generating power	Cost per horse power per year
Steam	$15 00
Gas engine	10 00
Water power at Niagara Falls	3 75
From intermittent natural sources	4 [illegible]0
Water power under exceptionally favorable conditions	2 [illegible]0

It will be seen that while this method of producing power is much cheaper than a steam or gas engine it is approximately on a par with water power under fairly favorable conditions such as prevail at Niagara Falls This is because in the present method and with water power the capital first cost is the determining factor The capital first cost per horse-power by the present method using a solar tank is approximately $62 50 and using windmills in conjunction with the solar tank approximately $4[illegible] The capital first cost at Niagara Falls is approximately $40

The new method gains chiefly from the higher fall and from the cheaper and more efficient water motor also from the fact that only one seventh as much water has to be handled and that there are no dams to build or large buildings to erect It loses from the fact that a pump has to be supplied also a steam turbine and solar tank or windmill The method therefore may not be of so much value in places favorably situated for obtaining water power Localities so favored are however comparatively few in number

*Abridged from a paper read before the British Association for the Advancement of Science

*We are not aware that a temperature so much above [illegible] has ever been obtained in any published experimental work Ed

The Argon Process

In a paper presented to the Academie des Sciences M Georges Claude shows that it is easy to obtain argon in the laboratory by using oxygen furnished by the liquefaction of air to begin with In practice such oxygen is above 96 per cent pure and the principal impurity at least with the oxygen which the Claude process procures is argon whose volatility is intermediate between those of oxygen and nitrogen Only a lack of tightness in the oxygen compression apparatus would give a predominance of nitrogen Oxygen at 96 per cent, for instance contains normally more than 3 per cent of argon and hence it is a raw material which is three times as rich as air for the argon process Besides, the oxygen is much more easily absorbed than nitrogen In the method used by the author, he absorbs the oxygen by means of copper and the nitrogen by that of magnesium We can regain the copper in the metallic state and the expense for magnesium is small owing to the low percentage of nitrogen The oxygen is taken from the steel bottle by means of a suitable expansion valve It is sent into a copper tube filled with reduced copper and heated to a low redness The residue traverses a smaller iron tube full of powdered magnesium heated to redness, and then an oxide of copper tube designed to absorb [illegible] due to any initial dampness of the copper or oxygen The absorption of the oxygen by copper takes place very rapidly and would cause the fusion of the oxide if the delivery of gas were too high but we should avoid such fusion in order to keep up the porosity of the mass this allowing of an easy recuperation of the metal by a hydrogen treatment so that in practice we use continually the same tube For instance he uses a copper tube 60 centimeters (23 6 inches) long and 6 centimeters (2 36 inches) diameter heated over the whole length from the start of the operation by the flame of four Bunsen burners of the butterfly type The tube is charged with 2 5 kilogrammes (5 5 pounds) reduced copper mixed with some fine turnings so as to increase the permeability of the mass An iron tube is charged with magnesium, the tube being 40 centimeters (15 7 inches) long and 3 centimeters (1 18 inches) in diameter, heated to redness on a grating The copper oxide is placed in a silica tube 30 by 2 centimeters (11 8 by 0 78 inches) kept at low redness This apparatus allows of treating 3 liters (85 cubic feet) of oxygen per minute and thus we obtain 4 to 6 liters (113 2 to 170 cubic feet) of argon per hour during 2 hours, or 8 to 12 liters (226 to 339 7 cubic feet) before exhausting the copper The best method of following the operation is to take at the start the densities of the gases collected until we obtain the density due to argon. No new observations need be made before the last half hour for the operation is very regular and the absorption quite complete The recuperation of the copper by hydrogen in the same conditions of heating as above can be completed in less than 1½ hours

The Pennsylvania Railway Company announces that it has instituted a new plan of training men to maintain and operate signals It has appointed four signal apprentices who are college graduates The different divisions of the lines east of Pittsburg have started signal schools where experienced men give instruction to the division signal employees The importance of this step is indicated by the fact that whereas in 1902 there were but 7 891 interlocking functions in operation on the lines east of Pittsburg in 1908 this number was 20 725 These functions are operated by 8 792 levers A total of 12 408 signals is in service covering 3 385 miles of road or over 70 per cent of the mileage Signal apprentices will serve a three years course and will then be eligible for the position of assistant signal inspector in the signal engineer's office After attaining this they will be considered for appointment to the following positions Assistant supervisor of signals supervisor of signals inspector, assistant signal engineer, and signal engineer

The "Holy Mountain"

Exploring in the Sinai Peninsula

By Harold J Shepstone

ALTHOUGH the famous Monastery of St Catherine on Mt Sinai is visited every year by a number of Greek and Russian pilgrims the Sinai Peninsula may be said to be little known either to Europeans or to Americans Yet its ancient history renders it one of the most sacred places in the world while its precipitous mountains wonderful gorges strange fertile oases full of Bedouin life and its monastery perched high up the barren heights make the region one of untold interest to the traveler

In view of these facts an account of a somewhat extensive tour recently made in the Peninsula may not be without interest Our party numbered four each hailing from a different country One was a member of the American Colony in Jerusalem who acted as photographer and with what result the accompanying photographs must testify After getting our permits from the Egyptian War Office we took boat from Suez We also had letters of recommendation to the convent Mt Sinai from the Greek Convent of Cairo As we steamed out of the harbor of Suez looking westward toward the mountains of Atakah there could be seen the probable locality where the Israelites crossed the Red Sea.

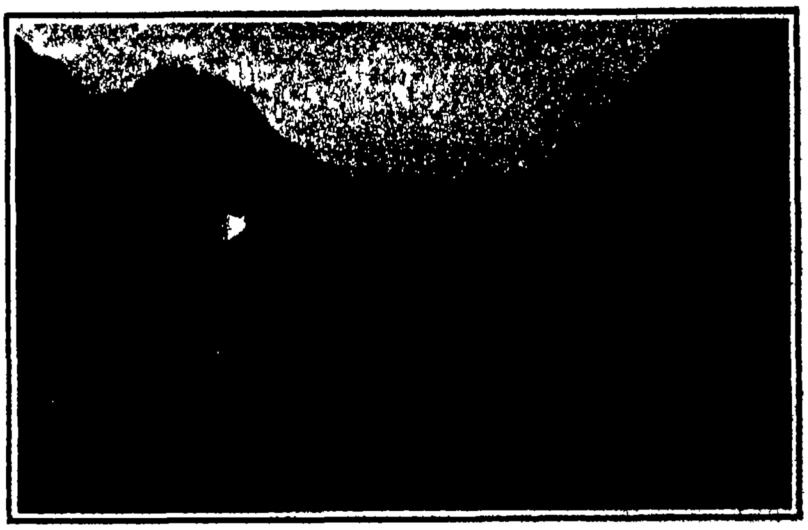
Our steamer had seen forty nine years of hard service and bore marks of it on every plank, every door lock seemed to be worn out so that there was continual banging day and night When the vessel pitched and the stern was raised out of the water the rudder shook and vibrated as if it could not stand a second wrench Some few hours out we lost the anchor in thirteen fathoms of water This was daringly recovered by an Arab diver He was let down on a leaden weight, attached a hook to the anchor which was then drawn up In all the man was three minutes under water The deck of the vessel was full of devout Mohammedans making their pilgrimage to Mecca. There were 120 of them, and they seemed enough yet on the previous voyage this same vessel carried 506 of these pilgrims, who by force took possession of the first and second-class accommodations. The crew could offer no resistance as the pilgrims were well armed

Our first view of Sinai [illegible]

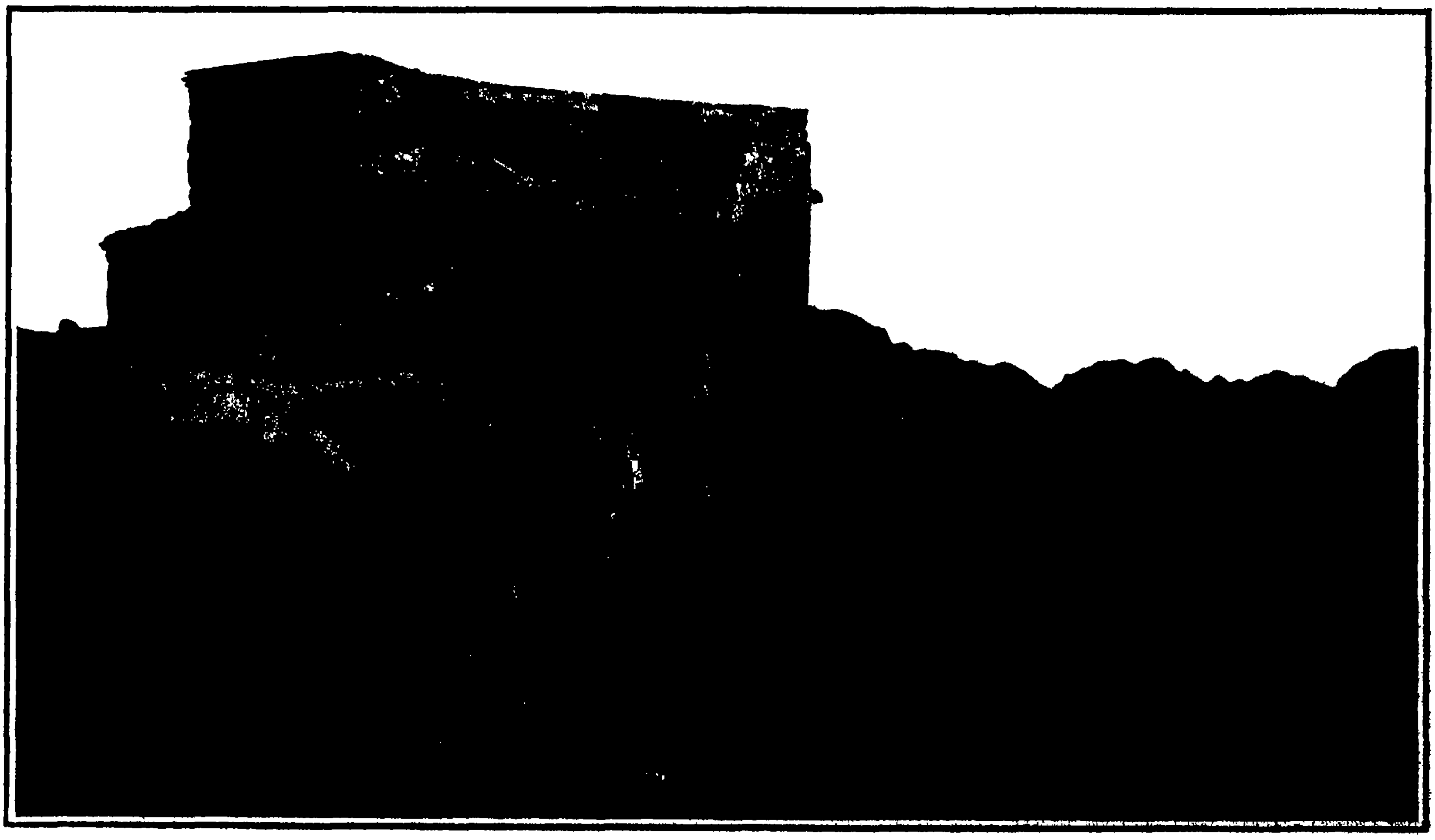
steamer entered the harbor of Tor The sun was just rising over the highest peak and it was very impressive and beautiful The little harbor is protected by a natural breakwater of two coral reefs with just sufficient space between them to allow a boat to enter Tor is the great quarantine station of pilgrims returning from Mecca There is an excellently arranged series of buildings for the use of the quarantined pilgrims and the fumigating and disinfecting quarters are colossal structures very modern and quite up to date. This international quarantine station is enlivened during the period of the detention of pilgrims by many thousands of "the faithful camping out, if they are too numerous for the rooms

In 1904 there were as many as 17 000 here at one time There must elapse ten days without a death before the pilgrims are allowed to proceed on their journey and there were many deaths among this great multitude so that it appeared as though they never would be able to proceed. The pilgrims then agreed that for the next ten days there should be no more [illegible]

RESTING AT THE OASIS OF EL WADI N RTHEAST OF TOR AND PREPARING FOR THE JOURNEY ACROSS THE WILDERNESS OF SIN



HILL OF AARON SO CALLED FROM THE TRADITION THAT ON ITS SUMMIT THE GOLDEN CALF WAS SET UP



THE SUMMIT OF JEBEL MUSA WHERE MOSES RECEIVED THE TEN COMMANDMENTS

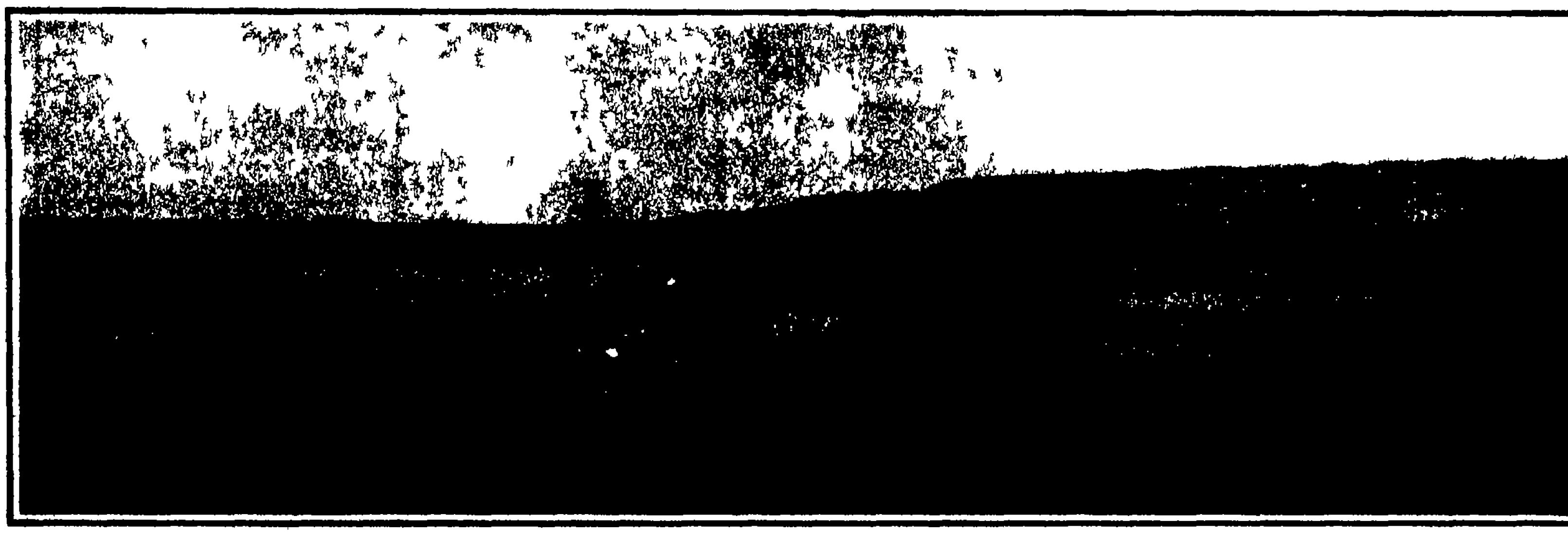
THE HOLY MOUNTAIN

ing and shifting the sand where the tents had stood revealed the ghastly sight of the remains of several pilgrims, who having died, had been buried in the sand under the tents by their comrades The village of Tor will no doubt dwindle into insignificance now since there is a railroad connecting the Damascus and the Haifa railroad with that of Medina and most of the pilgrims will surely prefer that route But one only hopes that the same energetic measures for preventing the spread of cholera plague etc by these returning hordes of devotees will be adopted by the Turkish authorities at the quarantine station on the Mecca railroad otherwise the health of Europe will be greatly imperiled

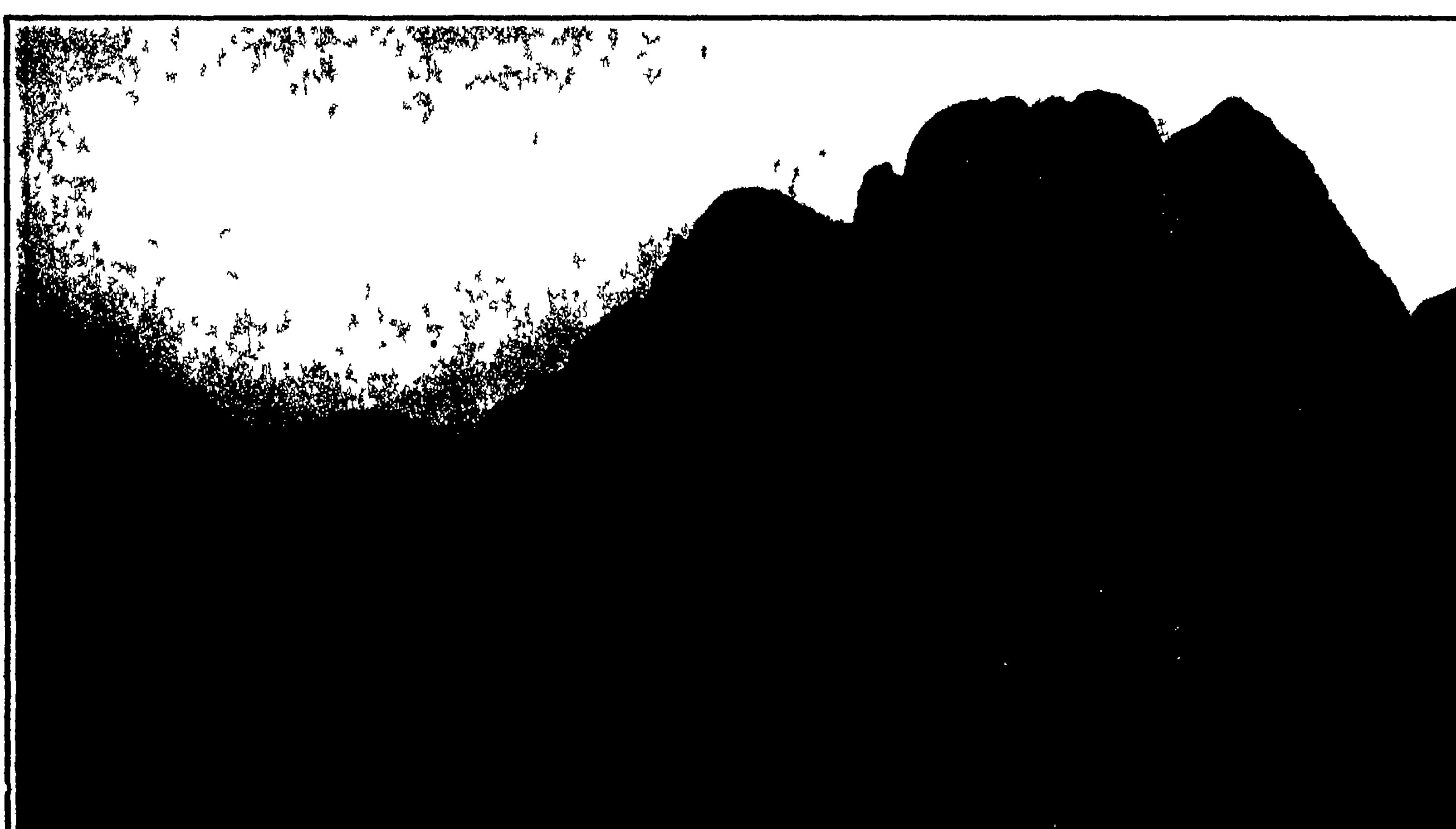
As soon as we dropped anchor in Tor harbor a sailing boat came out with the superior of the Greek and another at Tor There are only about 5 000 to 6 000 inhabitants as that is all that can be supported on this barren peninsula. The Arabs are divided into tribes each tribe having a Sheik who wields considerable authority The sacred associations of the region draw a number of pilgrims chiefly Russian and Greek to the Convent of Mt Sinai These, of course need camels to carry them and their water and food so in this way a number of the Bedouins gain a livelihood Many own a few palm trees either on the plain or in the Oasis of Firan They take the dates to Suez on camelback and trade them for corn and millet Although the mountains are so barren yet many shrubs and plants that grow being aromatic are much liked by camels goats and sheep and a fair number of goats and of sheep are raised

northeasterly direction aiming for Wadi Hebran The wind was blowing hard and the sand stung our faces considerably After traveling two or three miles we came to the Oasis of El Wadi where we stopped long enough to water the camels and to fill our water skins from the well of good water From here the ground became less sandy until it finally grew hard and gravelly This continued until we reached the foot of the mountains just as the sun was disappearing when we camped for the night

The view from our tent when we woke early in the morning will never be forgotten The peak of Mt Serbal so rugged and imposing was lit by the sun which was rising over Jebel Ka herin The plain was studded with large boulders of granite which had been washed down by the winter torrents and here



THE NORTH END OF THE GULF OF SUEZ SCENE OF THE PLACE WHERE THE ISRAELITES CROSSED THE RED SEA



WADI ER RAHA

THE HOLY MOUNTAIN

convent there to assist us in landing He told us that our camels were ready and we could at once commence our inland journey When we got to shore however we found that a contract had to be drawn up between us and the Bedouin Sheiks and that trivial affair took no less than three hours to complete satisfactorily As the Bedouins take it in turns to escort parties to Mt. Sinai and every one claimed it was his turn it took additional time to finally settle their fighting and shouting.

The Sinai Peninsula, it may be added is bounded on the north by the desert of Tih or the Wilderness of the Wandering on the south by the Gulf of Suez and on the east by the Gulf of Akaba It is governed by the Intelligence Department of the Egyptian War Office. One officer is stationed at Khalat el Nakhl,

We were very cordially entertained at the Greek convent at Tor during the few hours before our start As soon as we arrived we were taken into the comfortable reception room and the usual jelly served A tray is brought in on which was placed a glass of jelly several spoons and a little glass of date brandy and you are supposed to take a spoonful of jelly only Once one of my friends to whom it was passed and being unacquainted with the customs thought that he had to finish the whole glass of jelly But after five or six spoonfuls finding that impossible the host seeing the predicament my friend was in came to the rescue and explained the manner of procedure

It was about noon by the time we had our loads arranged chosen our riding camels and got started We struck across the desert or plain of El Kaa in a

and the c g w a sl ittim tree S after moving from our camp we came to the entrance of the valley of Wadi Hebran and found on the steep cliffs of the rocky ravine several Sinaitic inscriptions These were mostly Nabataean ut ly a people that inhabited the rock hewn city of Petra and worshiped sun moon and stars

The road along this Wadi is quite good and during the spring there is a stream of water here Even as we passed in September there was water flowing for some distance from the fountain head and all along the sides of the little brook grew luxuriant vegetation At noon time we rested under the shade of a group of palm trees watered by a little spring This was the most beautiful part of the Wadi Here were supported several Bedouin families They were just

gathering their crop of dates The men easily climb the trees and cut the dates off in big clusters These are picked off the stems and dried in inclosures fenced in with palm branches

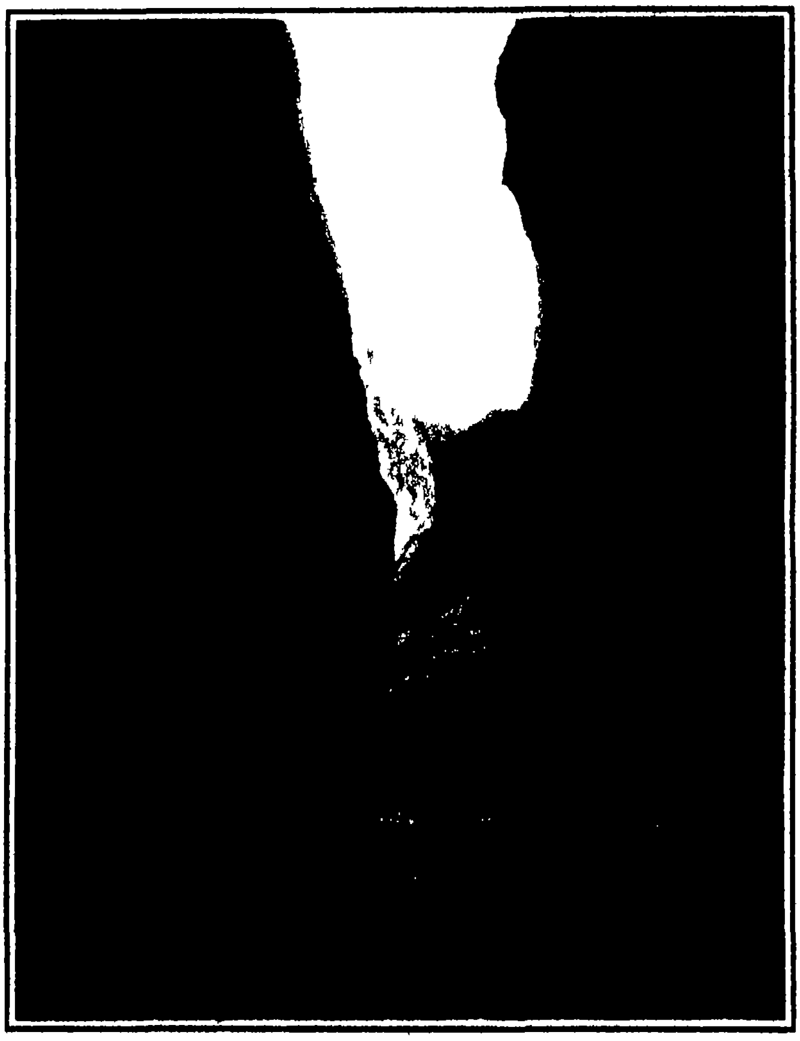
As we ascended during our ride in the afternoon the valley became more sterile with no water and little vegetation The road too was rough and at a height of 3600 feet we came upon our first sight of the only remains of former habitation These were the Nawamis a sort of low stone buildings which the Bedouins attribute to the Israelites The tradition is that for protection against a plague of mosquitoes they were built by them but scientists think they were either graves or huts of the ancients

As we wished to visit Wadi Firan we left the main route to the convent and camped for the night in a desolate valley with no water and no verdure except some juniper bushes During the night we heard the laughing of the hyenas They are quite numerous here and many of the graves of the Bedouins which we passed had been dug into by these repulsive animals which prey on corpses and carrion In these mountains wild goats are found and occasionally leopards Before sunrise next morning we were off to the Oasis of Firan determined to return to our camp that night We were much struck by the strange suffering from fever, caused probably by the stagnant water in some of the gardens, and a diet consisting almost entirely of dates By noon time we had traversed almost the entire oasis, and came to the ruins of an old convent This was one of the great centers of the Anchorites in the early centuries, and the sides of the valley are full of their tombs They came to this spot as it is at the foot of Mt Serbal which the earliest traditions affirm to be the Sinai of the Bible Later as the monks of Jebel Musa, at the Monastery of St Catherine became powerful, they claimed that around their locality transpired all the acts connected with the giving of the law Eusebius the earliest Christian historian gives the Oasis of Firan as the battlefield between the Israelites and the Amalekites

On our return to camp we simply retraced our steps, returning by the same route we had come and next morning set out for the Monastery of St Catherine As we were traveling along, suddenly one of the Bedouins began examining the ground and following some track He then assured us that a camel of his had passed along there the day before They can tell their own animals by their foot prints, and as they allow them to roam at will over the mountains for months at a time they get very expert in tracking them when they need them They always keep within [illegible] protects it, and [illegible] occurred at [illegible]

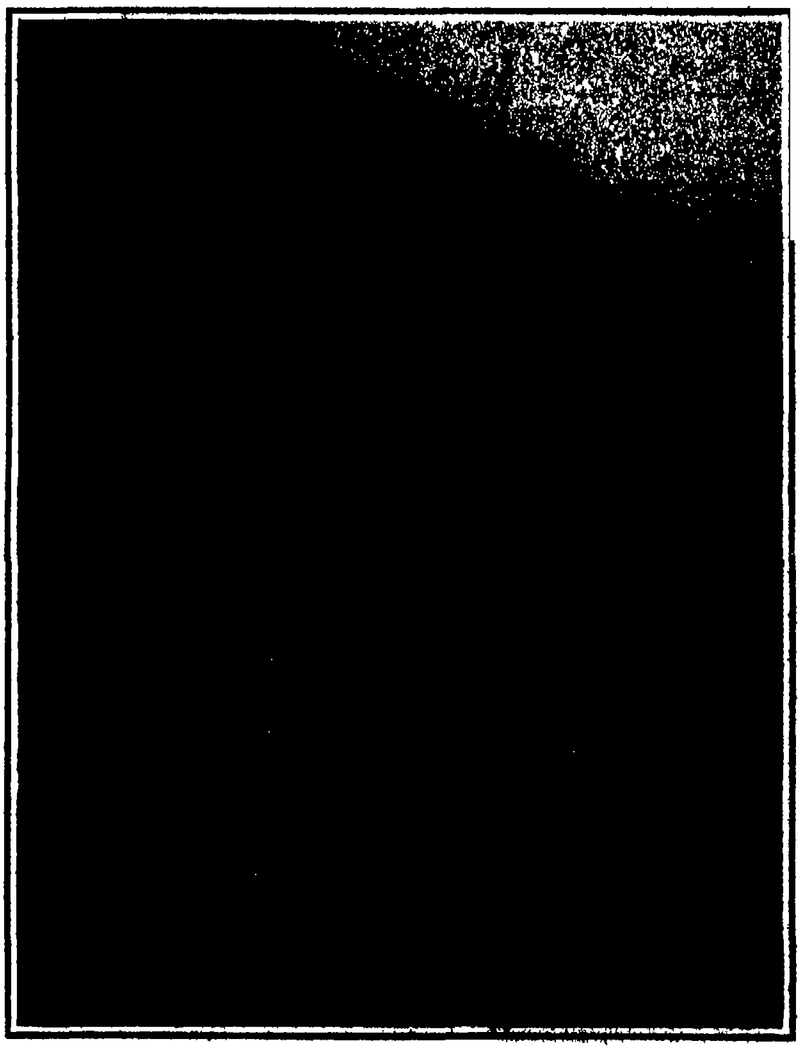
One of the monks was appointed our guide up Jebel Musa (mountain of Moses), which we undertook on the early morning of the second day after our arrival. We ascended by the pilgrims' steps, a steep path built by the monks, each step being a slab of granite. A little chapel on the way up marks the spot where the Virgin appeared to the monks as they were deserting the monastery on account of a plague of vermin and promised them deliverance if they would return. They did so and found that the tormenters had disappeared But tourists agree that they have since returned Continuing our upward way we next come to an archway through which the path leads Long ago a hermit named St. Stephenous zealously guarded the gate, and would allow no one to ascend the Holy Mountain unless he could prove his worthiness and that his record was good If this was proved he would administer the sacrament and allow the pilgrim to ascend One day he was found at his post but lifeless

The path after twisting in and out among huge boulders of granite, suddenly opens on a small plateau with a gigantic cypress tree and a round mound or hill in the center The monk told us that here Moses gathered the elders of Israel together Here also is a



WADI ISLA A GRAND AND ROMANTIC GORGE

At point wh[illegible] as taken the [illegible] is 18 feet in width while the rugged granite walls on either side re[illegible] hundreds of feet in height



VIEW INSIDE THE MONASTERY OF ST CATHERINE SHOWING CHURCH OF THE TRANSFIGURATION AND THE MOSQUE SIDE BY SIDE

THE HOLY MOUNTAIN

seams of black diorite in the gray and red granite slopes These seams run invariably from north to south and the dividing line between the different colors is as marked as if it had been cut with a knife As we neared Wadi Firan we could see where the valley narrowed to only a few yards in width This was at El Huwah the Arabic for little door Undoubtedly this pass was utilized by the Children of Israel in their journey to Sinai as there is no other route practicable for a large body of people

Soon after this as we turned a bend in the valley a most exquisite picture met our eyes It was the beginning of the Oasis of Firan the veritable Pearl of Sinai Out of the apparently parched desert sprang a beautiful stream of water making an Eden of the next seven miles of the Wadi No one can appreciate such a change such a jump from sterility into fertility unless they have actually traveled the weary desert and come to such a haven Our ride through the palm gardens was very enjoyable as they were full of Bedouin life At no other season of the year could we have witnessed the date harvest which was just being gathered After the dates are gathered almost all the Arabs leave the gardens and seek the hills and plateaux where pasture is obtainable for their animals. We noticed that many people in the oasis were a few hours journey from a spring The road was very rough and tedious at Nabk el Haweh, but we were well repaid when we got to the summit of the defile The view was grand and commanding. Jebel Musa Jebel Katherine and many other peaks loomed into view From here our goal was in sight A ride of a few hours more brought us to the hospitable Monastery of St Catherine We pitched our tent in the convent grounds and at once went to pay our respects to the monks and to present our letter of introduction They had already got word of our coming, so were on the lookout for us.

The monastery or convent as it is generally called although only monks reside here is built in a narrow valley, at the foot of Jebel Musa. It has almost the appearance of a fortress having a massive wall surrounding it And such it was for we learn that Justinian built a fort on this site in the fourth century expressly for the protection of the monks. He also strengthened them by a present of 100 Roman and 100 Egyptian slaves with their wives and children. The descendants of these very slaves, the Jebeliyeh, still live at the convent and serve the monks, although they have adopted Mohammedanism. There are now about twenty five monks living here, Greeks from Cyprus or Crete. As the church is Greek Orthodox, Russia [illegible] chapel said to mark the cave where the prophet Elijah rested when fleeing from Jezebel, and where he heard the still small voice From this point to the top the ascent is very steep but thanks to the monks, it is not difficult, as they keep the steps in repair The whole summit of the mountain is a huge mass of solid granite The upper point is over 700 feet high and here is pointed out the rock where Moses saw the glory of God pass by and where he received the Ten Commandments Some one described the view from here as looking upon an enlarged section of the moon. It is well put for no greater desolation or bleakness could be found anywhere Jebel Katherine close by, is very imposing It is the highest peak of the range Toward the east are seen chain after chain of somber looking mountains and beyond the Gulf of Akaba.

After descending to the monastery we spent the rest of the day in visiting the locality where Aaron made the "Golden Calf" and then on the Plain of Er Raha. This is a broad fine plain at the foot of Jebel Safsaf and Jebel Musa, where Israel must have camped while Moses ascended Sinai. The following morning we devoted to the monastery The present entrance is through a small, heavy iron door in the western [illegible] [illegible]

used in case of a siege. Until recent years visitors were admitted to the monastery by means of a rope, which was attached to a person, who was then drawn up over the wall.

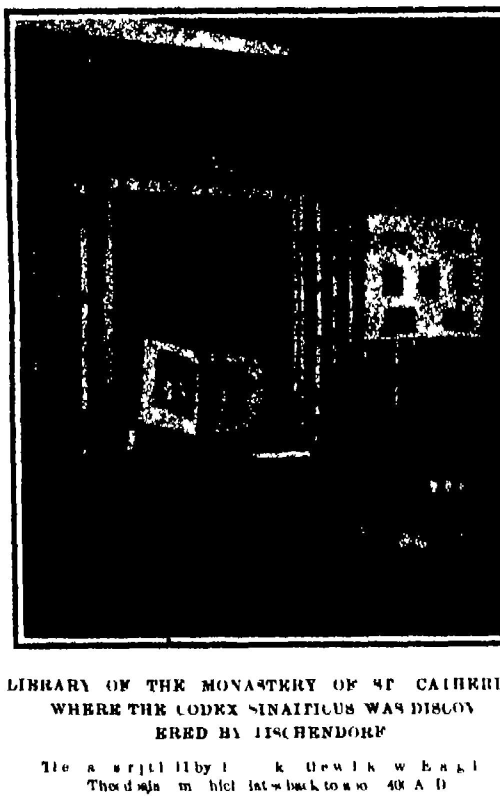
On entering we were much surprised at seeing the minaret of a mosque side by side with the bell tower of a Christian church. We learned that the erection of the mosque was a diplomatic move on the part of the monks to save themselves from massacre by the Mohammedans, since through their care of the mosque they thus obtained the favor of the Islams The church is an early Christian structure built in memory of the Transfiguration of Christ The mosaics which adorn the apse are very old and very valuable The monks took us to one side brought a table and with an air of great mystery opened a small marble sarcophagus out of which they took the skull and one hand of St Catherine the martyr of Alexandria These remains were bedecked with most costly jewels Each of us was presented with a souvenir ring taken from the coffin

We next visited the Chapel of the Burning Bush where we had to take off our shoes for it was holy ground The library was of most interest to us as this is where Prof Tischendorf discovered in 1844 the Codex Sinaiticus a Greek manuscript of the Old and the New Testament It dates from 400 A D He was a German scholar and devoted his whole life to the discovery and the study of ancient biblical manuscripts On this errand he visited all the libraries of the East but quite unexpectedly found this the "pearl of all his researches in the Sinai convent He saw some leaves of parchment in the waste paper basket and was told that two similar lots had been burned Among them were parts of the Greek Septuagint the oldest looking manuscript he had ever seen He was allowed to take what he wished of them and got forty sheets but he displayed so much joy with his gift that the monks suspected their value and would give him no more On his return to Europe he tried by every means to procure the remaining sheets but without success Fifteen years later he returned to Sinai armed with letters from the Czar On knocking at the door of the convent one of the monks put out his head over the ramparts and after receiving his letter the monks lowered the rope and hoisted him up Still he accomplished nothing and was preparing to leave when the steward of the convent invited him into his cell and showed him a bundle of old manuscripts which he found was just what he was searching for This time he concealed his joy and carelessly asked if he could take them to his room while he found out their real value They were given to the Czar and are now in the library of St Petersburg

Our return to Tor was by a different route from the one we came by We went south and followed Wadi Isla This is the most picturesque gorge in Sinai especially for the grandeur of the precipitous rocks or cliffs that inclose it They rise on either side in some instances two to three thousand feet The bed of the torrent is narrow not exceeding five yards in some places and through this rushes a mighty volume of water after a rain storm sweeping all before it We camped for the last night of our desert journey at the mouth of this gorge It was most oppressive and hot At midnight the thermometer registered 100 deg F!

Alcohol

NUMEROUS alcohols are known to the chemist but that which he describes as ethyl alcohol is the one which is meant when we speak simply of alcohol Primarily it is obtained by distillation from a great variety of materials—wines sugars grain and various other substances—each of which yields a spirit containing various ethers, essential oils and other compounds which give it a characteristic odor and flavor When intended for drinking purposes in the form of whisky etc the retention of some of these various ingredients is necessary but by a special process of distillation it can be obtained free from them in which case it is known as "patent or 'silent spirit Water is always present in this and the strength of the silent spirit may vary greatly One particular variety of still is reputed to produce silent spirit containing only 2 per cent of water which is practically equivalent to what we call absolute alcohol but usually there is much more water than this and the spirit has to be "rectified by redistilling In the more ordinary process of production the result of repeated distillation or rectification is a product containing about 90 per cent by volume of pure alcohol and 10 per cent of water, which is known as rectified spirits or spirits of wine Continuing the same process will not reduce the quantity of water any further and treatment with lime is necessary before a stronger spirit can be produced. By such treatment it is, however, possible to get rid of nearly all the water, and when not more than 1 per cent remains the fluid is called absolute alcohol. The actual strength of this is usually about 99.5 per cent. This is, of course, the purest and strongest alcohol obtainable but it is expensive, and stronger than is always required If it is to be used mixed with water, we may just as well purchase a weaker and slightly cheaper variety and the next definite strength is the so-called rectified spirit" which contains 84 per cent by weight or nearly 90 per cent by volume of pure absolute alcohol This



LIBRARY OF THE MONASTERY OF ST CATHERINE WHERE THE CODEX SINAITICUS WAS DISCOVERED BY TISCHENDORF

The [illegible] by [illegible] The [illegible] back to [illegible] 400 A D

rectified spirit is also known as spirits of wine but the latter term being also used somewhat vaguely to cover alcohol in general it is usually best to ask definitely for rectified spirits

The next definite strength of alcohol is known as proof spirit or as spiritus tenuior by the druggist This is a standard strength adopted by the revenue authorities and it contains 49 per cent by weight or about 57 per cent by volume of pure alcohol Other strengths of alcohol are frequently described in terms of proof spirit so that it is well to understand what it means Rectified spirit is often described as 56 over proof which means that the addition of 56 parts by measure of water to 100 parts of rectified spirit will give proof spirit It also means that we must take 156 parts of proof spirit to get as much alcohol as is contained in 100 parts of rectified spirit Weaker spirits are styled under proof and 20 under proof means that 100 parts of the spirit contain only 80 parts of proof spirit It is necessary to avoid confusing proof spirit with absolute alcohol which is nearly double its strength

A good deal of confusion has arisen over the matter of methylated spirit Originally methylated spirit consisted of a mixture of 90 per cent by weight of rectified spirit with 10 per cent of wood alcohol or wood naphtha This compound was sold duty free and could be used for most of the purposes for which pure alcohol was wanted excepting of course that it could not be used in medicines and it was assumed that no one would care to drink it as a beverage This assumption proved however to be a mistake it was drunk in large quantities and so some years back petroleum was substituted for the wood spirit the new compound being very unfortunately still called methylated spirit This is allowed to be sold as freely as the old spirit but restrictions have been placed upon the sale of the original real methylated spirit The newer compound miscalled methylated spirit but more properly described as denatured spirit is useless for most of the purposes for which the older variety was employed It is indeed of little use for anything except burning and the manufacture of varnishes It cannot be used as a cheap substitute for pure spirit in chemical and photographic work and therefore if the cost of pure spirit is a consideration the old methylated spirit which is now known as industrial spirit must be procured

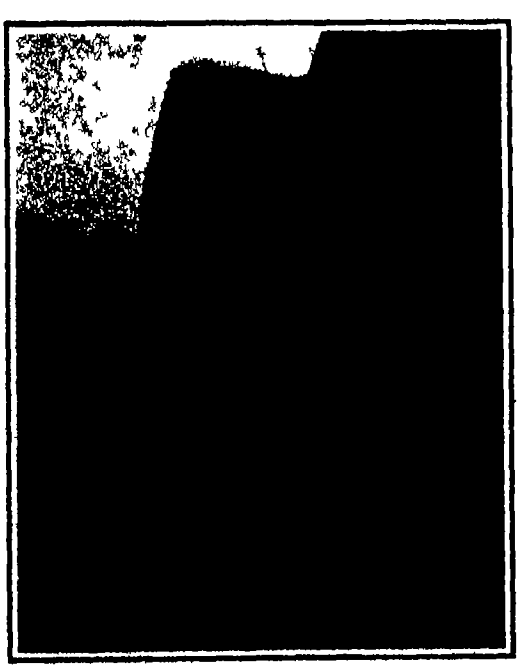
Unfortunately there is yet another variety of so called methylated spirit which consists of the ordinary denatured spirit with one ounce of shellac dissolved in each gallon This is technically called methylated finish but oilshops frequently supply it when methylated spirit is asked for Indeed in some cases it is the only kind kept in stock

Alcohol is used for a variety of purposes in photography for drying negatives mixing carbon sensitizing baths making varnishes and sometimes for dissolving developing agents For all these purposes industrial alcohol can be used safely though we prefer pure spirit for developers In making up solutions with alcohol there are one or two points that should be noticed A mixture of alcohol and water is of less bulk than the sum of the volumes of the two ingredients the shrinkage being greatest when 52.3 measures of alcohol are added to 47.7 of water The total measure of the mixture is not 100 but only 96.36 measures so that the diminution of volume is 3.64 per cent The most important point to observe is that this shrinkage of volume is accompanied by a marked rise of temperature so that if we add a developing agent dissolved in alcohol to water at normal temperature the mixture will for some few minutes be well above the normal temperature and the resulting developer may be too warm It should therefore always be cooled down before use—British Journal of Photography

French Butterfly Farms

THERE are in France butterfly farms the object of the farmers being to rear rare genera of the Bombycidæ the silkworm family By crossing some new varieties have been obtained and these are much sought after by museums of natural history

Endeavors are also being made in France to acclimate species of silkworms indigenous to other countries The farms contain oaks ailanthus trees pines plum trees castor oil plants and other plants the leaves of which serve as food for the caterpillars Cocoons are hatched on branches protected by gauze and for the sake of uniform temperature the insects are often kept in a room until after the first molting when they are placed on bushes in the open air and protected from birds by coverings of muslin or tulle



ANCIENT WAY OF ENTERING THE MONASTERY OF ST CATHERINE

PRIMITIVE ELEVATOR IN THE MONASTERY OF ST CATHERINE NOW IN ACTUAL USE

THE HOLY MOUNTAIN

The Knight Valveless Motor

A Highly Efficient Hydrocarbon Engine

The earliest explosion motors those of Lenoir and Otto were constructed on the model of the steam engine from which they borrowed the slide valve Separate valves of the ordinary type were subsequently adopted and for many years such valves were employed in all explosion motors but a tendency to revert to the original solution of the problem has recently become manifest In several motors of recent invention the valves are replaced by sliding devices which however are not operated by the piston and bear no resemblance to the slide valve of a steam engine

Separate valves have been tried and condemned They are accused of causing many breakdowns due to broken valve rods and adhesion of the valve to its seat They also throttle the entering stream of gas and make too much noise It is true that some motors provided with valves are almost silent and that most of the objectionable features of the valve are not inherent but are due to faulty construction At very high speeds however the valves fail to follow the contour of their operating cams accurately and run wild causing a great loss of power as shown by the indicator diagram

Hence valveless motors are coming into vogue The new Knight Hewit, Bingham Mercedes and Rénaud motors are of this type The Knight valveless motor which appears to be nearly perfect in construction and operation is now made and used by the celebrated automobile firms Minerva in Belgium Pankard-Levassor in France Mercedes in Germany and Daimler in England

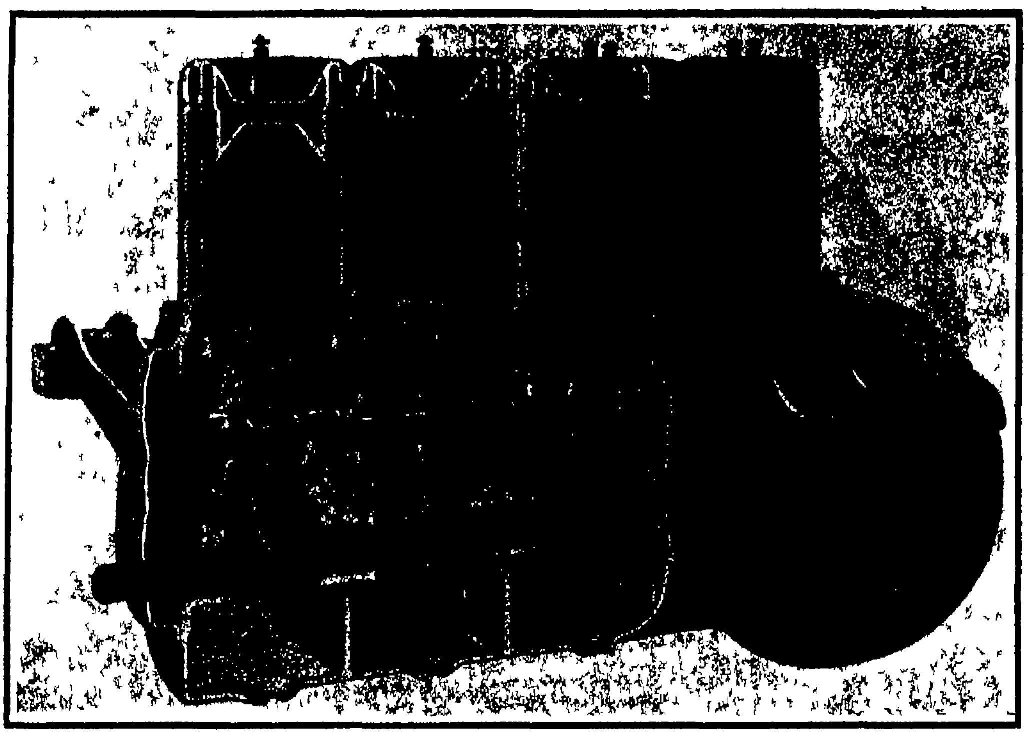


Fig 1 —THE KNIGHT VALVELESS MOTOR

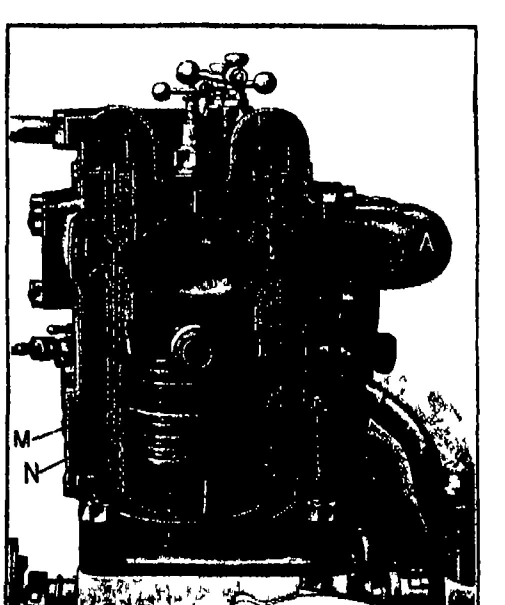


Fig 2 —VERTICAL SECTION OF CYLINDER OF KNIGHT MOTOR

The Minerva Knight valveless motor has four cylinders connected in pairs The top of each cylinder has two lateral orifices which communicate respectively with the supply pipe *A* and the exhaust pipe *E* (Fig 2) The cylinder is surrounded with a water jacket and is lined by two thin hollow cylinders or sleeves *M* *N* which have large lateral openings and which move in such a manner that they control the aspiration and exhaust of gas by bringing these openings opposite the smaller orifices of the large cylinder at the proper times These sleeves are moved up and down by the rods *E* and *F* connected with eccentrics on the shaft *A* (Fig 3) which makes one revolution in each two revolutions of the main shaft *G* In a motor of 35 horse-power the travel of the sleeves is one inch while that of the piston is more than five inches Hence the velocity of the sleeves is less than one-tenth that of the piston The openings in the sleeves are so wide that the gases enter and leave the cylinder much more freely than they could do through valves

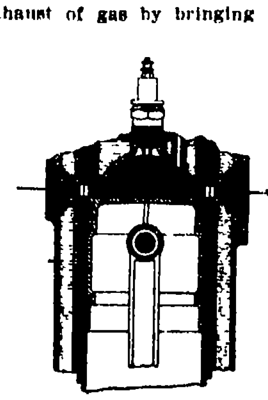


Fig 4 —THE ARROWS SHOW THE SHORT AND STRAIGHT COURSE OF THE GASES IN A VALVELESS MOTOR

The motions of the sleeves and the positions and dimensions of their openings are so adjusted that each port is closed by one or both sleeves during three fourths of the cycle and is kept open during the remaining fourth of the cycle by the simultaneous apposition of the openings in both sleeves upon the orifice in that side of the cylinder During the first down stroke of the piston (aspiration) the inlet port is open and the exhaust port closed during the first up stroke (compression) and the second down stroke (explosion) both ports are closed during the second up stroke (exhaust) the exhaust port is open and the inlet port closed At the end of the cycle, however the exhaust port remains open for a very short time after the inlet port has opened so that the products of combustion are completely expelled by the entering gas

This motor is very silent, especially at high speeds, and is so flexible in operation that the speed of an automobile can be varied within very wide limits by simply controlling the admission, so that the differential need not be used, except for starting and backing Another great advantage is presented by the constancy of compression which is difficult to obtain with ordinary motors because of leakage at the valves which also causes the carbureter to work badly and produces a loss of power The absolute constancy of compression in the Knight motor is the cause of its perfectly uniform speed for the intervals between

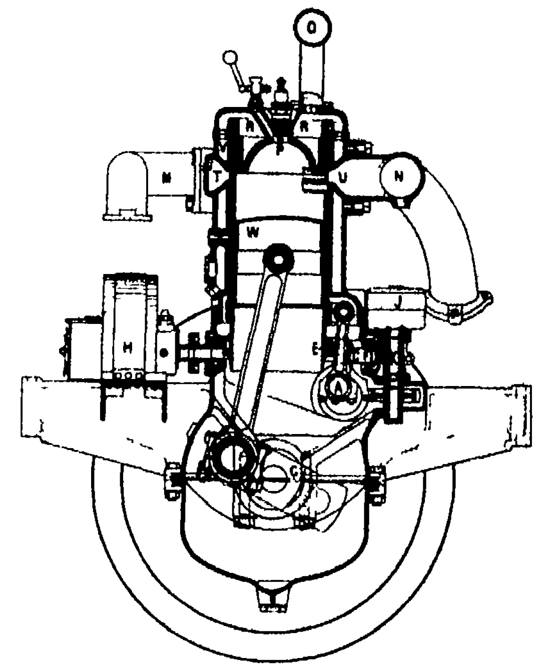


Fig 3 —DIAGRAM OF CYLINDER OF KNIGHT MOTOR

successive explosions cannot be vigorously equal unless the compression is always exactly the same in all of the cylinders In order to satisfy this condition there must be no leakage and the cylinders must be exactly equal in volume It is impossible to obtain this perfect equality in castings but the cylinders of the Knight motor are worked to the required dimensions and polished so that they present no projections containing particles of carbon which might become incandescent and cause premature explosions

The moving sleeves are lubricated by oil which is drawn by capillary action between them and between the outer sleeve and the cylinder and which fills horizontal grooves on the outside of each sleeve (Fig 2) In these conditions the width of the interval between the surfaces is within reasonable limits, of comparatively little importance All escape of gas during the compression is prevented by a ring *S* (Fig 2) which is pressed upon the inner sleeve by a spring and by a thin layer of oil between the ring and the sleeve

The vital parts of the Knight motor are the moving sleeves and the rods which connect them with the eccentrics At 1 200 revolutions per minute, the normal speed of the 35 horse-power motor the mean velocity of the sleeves is only 100 feet per minute

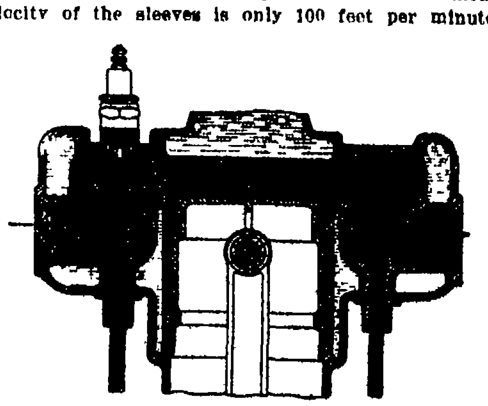


Fig 5 —THE ARROWS SHOW THE LONG AND CROOKED COURSE OF THE GASES IN A MOTOR WITH VALVES

The maximum stress exerted upon the sleeve by the connecting rod is 62 pounds for the inner sleeve and 33 pounds for the outer sleeve. Hence, there is practically no danger of fracture. The wear of the sleeves and the power consumed in operating them are also negligible. As they are driven by eccentrics, and not by cams, they cannot go wild at the highest speeds. They open and close the ports exactly at the proper instants and their openings are so large that the power of the motor increases with its speed.

In a comparative test of two similar motors and

with valves and the other without the valveless motor developed 30 and the valved motor only 25 horse power at 3,000 revolutions per minute. In another comparative test of two larger motors the valveless motor developed nearly 45 and the valved motor barely 35 horse-power at 1,800 revolutions. In each case the introduction of the sleeves made the effective diameter of the valveless cylinders smaller than that of their competitors, the difference amounting to ⅛ inch in the smaller and 1/6 inch in the larger motors. The inventor claims that the power consumed by the motor itself has been measured by experiments in which the motor was driven without gas by an electric motor and has been found to be only 13 per cent of the power developed by the motor when operated normally at the same speed so the efficiency of the Knight valveless motor is 87 per cent.

The form of the explosion chamber deserves special notice. Both the top of the cylinder and the top of the piston have a spherical curvature and the concavities of the two face each other. By this construction the surface is reduced to a minimum with respect to the volume and the exploding gases retain their heat and pressure longer than they would in a chamber having sharp angles between its bounding surfaces. The result is a smoothness and flexibility of operation comparable to those of a steam engine.

The Knight valveless motor has been subjected to many tests which have yielded some surprising results. For example a motor which produced 55 horse power at 1 140 revolutions per minute at the beginning of the experiment developed 56 horse power at 1 180 revolutions after running one hour. A motor of 38 nominal horse-power with cylinders measuring about five inches each way developed 55.3 horse-power continuously during a run of 5 days and 14 hours at 1 200 revolutions per minute and consumed 0.85 pint of gasoline per horse-power hour. The motor was then placed on a car weighing about 2 tons which made a tour of 2 1?4 miles at an average speed of 42.4 miles per hour. The motor was returned to the shop where it developed an average power of 57.25 horse-power during a run of hours at 1 200 revolutions and consumed 0.?? pint of gasoline per horse power hour. Hence it had gained 2 horse-power by use.

The valveless motor especially as it is represented by the type above described marks great improvement made at a time when the explosion motor was believed to have attained its maximum efficiency. It can be surpassed only by the turbine.

The Geological Society of America

Report of the Annual Meeting at Pittsburgh, Penn

By E. O. Hovey

The twenty third annual meeting of the Geological Society of America was held in the Carnegie Museum Pittsburgh on December 27th-29th 1910 under the presidency of Arnold Hague LL.D. of the United States Geological Survey. About one hundred members were in attendance and forty five papers were on the programme thirty one of which were read in full or presented in abstract with the aid usually of lantern slide illustrations and numerous diagrams and maps. One of the principal papers of the meeting was the address of the president upon The Origin of the Thermal Waters in the Yellowstone Park in which Dr. Hague summed up the results of many years of study in the park carried on mostly by him self and by parties working under his direction. He concludes that the waters of the geysers and springs are meteoric in origin and that their elevated temperature is due to aqueous vapors rising from the deeply buried but still hot igneous rock of the region.

Of the papers presented by other members of the Society by far the most important was that by Dr. E. O. Ulrich of the United States Geological Survey entitled Revision of the Paleozoic Systems of North America. This revision takes into consideration all the work done upon these widespread fundamental formations for the past three-quarters of a century and will form an octavo volume of about three hundred pages when published. It will doubtless arouse more discussion than any similar attempt at exact classification that has been undertaken.

Mr. N. H. Darton of the United States Geological Survey gave a brief summary of the results of studying the List of Underground Temperatures in the United States that he and several associates have been gathering together during the past fifteen years. A self registering thermometer of special type has been used in making observations in about one thousand deep borings. The rate of increase of temperature has been found to be quite variable but in places there is a marked relation to the geologic features of the region.

An Unusual Distortion of the Lower Kittanning Coal was the title of an interesting communication presented by Mr. Richard R. Hice of the State Geological Survey of Pennsylvania. Of the whole Allegheny series in western Pennsylvania no horizon is more regular and continuous than the Lower Kittanning coal indeed with its accompanying clay it is one of the best keys of the series. While there are many changes and local variations in the sandstones and shales caused in many cases by distinct erosion intervals this coal while not always workable is uniformly found over a large area. It is not marked by distinct foldings or distortions but by parallelism with both the under and overlying strata. At the site of Dam No. 5 on the Ohio River on the eastern edge of the Beaver Quadrangle between the towns of Rochester and Freedom a recent railroad cut exposes in a distance of some 600 feet a series of foldings involving the strata between the base of the Lower Kittanning clay and the horizon of the Middle (Upper) Kittanning coal (about 35 feet) in no way involving the underlying strata or those above the horizon of the Middle Kittanning coal.

The next paper was by Mr. W. T. Lee of the United States Geological Survey upon Further Evidence of an Unconformity in the So-called Laramie of the Raton Coal Field, New Mexico. This important series of coal-bearing rocks is now shown to be divided into two parts, each of which carries coal and the evidence is now pretty conclusive that there was a time break between the two formations. The lower is variable in thickness, and the observations indicate that the ancient surface represented by the unconformity was an undulating plain. Furthermore the character of the conglomerate base of the upper basin shows that this plain was one of erosion.

Professor William H. Hobbs of the University of Michigan followed with a suggestive paper on Repeating Patterns in the Relief and in the Structure of the Land. This paper was a discussion of patterns of relief which in many districts repeat themselves like a diaper design in architectural ornamentation. Such patterns have their origin in a fracture system intersecting the outer shell of the lithosphere and are best displayed in high latitudes because there the vegetable cover is scanty and frost action is the dominant weathering process. Where a country has further been partially submerged through depression the expression of such patterns is strikingly brought out in landscape and map alike. Studies made in Norway during the past season have shown that the origin of such patterns in that district is in part explained by the spreading of joint walls at more or less regular intervals within each series and resulting heavy frostwork on these planes. A line of drainage once established stream erosion and in some cases mountain glaciation have shaped the valley which is excavated. Patterns of relatively small size not only repeat but further group themselves into diaper like patterns of higher and higher orders. A compilation of data from widely separated districts in both North America and Europe reveals the existence of a primary pattern common to all areas which is however locally obscured by the superimposition of additional disorderly fractures. Much light is thrown from these studies upon the nature of geological faults which is also confirmed by later studies in seismology.

The upper surface of the great Triassic trap sheet in Montgomery County Pennsylvania sometimes shows a network of lines which closely resemble the sun cracks produced in a dry mud flat. These were described by Mr. Edgar T. Wherry of Lehigh University who stated that the lines were shown by a thin section to consist of coarsely crystallized augit and feldspar traversing a fine-grained ground mass and he accounts for them by regarding them as shrink age cracks developed by the sudden cooling of the molten trap against the contiguous shale the cracks being then filled up by molten material from the interior of the igneous mass.

A note of the recent International Geological Congress which was held in Sweden was given in a paper by Professor James F. Kemp of Columbia University who described certain of the pre-Cambrian rocks of Sweden and compared them with the corresponding rocks in North America. Much of Sweden is occupied by granites gneisses and schists which bear interesting resemblances to similar rocks in Canada, New England, the Adirondacks and other American regions. These Swedish beds are economically important for their content of iron ores and for their value in some places as sources of building and ornamental stones.

This paper was followed by one on The pre-Cambrian of Southeastern Ontario by Willet G. Miller and Cyril W. Knight of the Canadian Geological Survey. This region is classic ground in American geology and its rocks form an important part of the geological backbone of the continent but they are extremely complicated in their relations one to another and they still furnish field for active investigation.

A sketch of the local geology of the city of Pittsburgh was given by Dr. Percy E. Raymond formerly of the Carnegie Museum, but now of the Canadian Geological Survey. Dr. Raymond said in part: The city is situated along deep trenches, cut by the present rivers and in abandoned valleys of preglacial streams. Both were cut in a nearly level plateau, whose surface is from 500 to 600 feet above the present water level. Terraces and river gravels are well exhibited at many places along the abandoned valleys. The strata underlying the city are of middle and late Pennsylvania (coal measures) age, almost the whole of the Conemaugh and Monongahela series being well exposed. The nearly continuous exposures along the rivers afford an excellent opportunity for tracing the various beds and many interesting changes in sedimentation including erosional unconformities may be seen.

Professor Gilbert van Ingen of Princeton University in a paper upon The Shawangunk Grit and its Facial Relationships brought out the shallow water origin and shore characteristics of this small but important formation stretching from Shawangunk Mountains southwestward into Pennsylvania.

Then Dr. Percy E. Raymond described briefly the Chazy Formation in the Ottawa Valley making some new subdivisions and correlations with the New York beds and showing the influence of ancient geological features as barriers to the movement of animal life.

Professor D. W. Ohern of the University of Oklahoma gave a paper upon The Stratigraphy of the Lower Pennsylvania (coal measures) of Northeastern Oklahoma in which he gave a brief summary of the subdivisions of some two thousand feet of rock strata covering an area of some 3 700 square miles. The beds consist of limestones rich in fossils sandstones and shales poor in fossils and some beds of coal.

A paper by Professor William J. Sinclair of Princeton N. J. and Mr. Walter Granger of the American Museum of Natural History described in some detail the Eocene and Oligocene of the Wind River and Big Horn Basins in which the authors stated in brief that a comfortable superposition of Wind River beds on Wasatch and unconformable lower Oligocene on Uinta Bridger Lower Eocene have recently been found in the Big Horn and Wind River Basins respectively in northwestern Wyoming. These structural depressions partly inclosed by the Big Horn Bridger Owl Creek and Wind River Mountains were receiving sediments during the Wind River and Lower Oligocene but since then have been subjected to deep dissection by streams and wind erosion exposing sections of the tertiary filling. Nonvolcanic sediments predominate in these tertiary beds derived in large part from the rocks of the surrounding mountains shown by the abundant granite gneiss and sandstone pebbles in the channel sandstones interstratified with the alternately banded red and blue or yellow clays of the Wasatch and Wind River and by the presence of arkoses in the Uinta. Explosive volcanic eruptions are indicated by a few narrow tuff bands in the Eocene (Wind River) but especially by a great flow of andesitic agglomerate in the Lower Oligocene. Fine wind blown silts highly calcareous marls and siliceous spring deposits (chalcedony and opal) characterize the Oligocene above the horizon of the volcanic mud flow. Suggestions were offered in explanation of the alternation of color bands in the Eocene clays based on lithologic and paleontological data. Early Tertiary orogenic movements involving renewed uplift of the Big Horn arch are demonstrated by a great marginal anticline found in the Wasatch and by the numerous sandstone dykes apparently of seismic origin contemporaneous with the accumulation of the Wasatch clays.

A Quantitative Classification of Meteorites by Dr. Oliver C. Farrington of the Field Museum of Natural History is an attempt to arrange meteorites in accordance with the quantitative system of petrology as proposed by Messrs. Iddings, Cross, Pirsson and Washington. One hundred and twenty five meteorites have been assembled all of which fall within two

classes of basic lavas as proposed by these authors but the majority of the falls are outside of the groups in which terrestrial rocks actually occur

Some important papers on economic geology were read The first of these was by Professor J A Bownocker of the State University of Ohio upon The Clinton Sand as a Source of Oil in Ohio The author related the history of the exploitation of gas and oil in different parts of Ohio with particular reference to the distribution of the Clinton sand and its position somewhat east of the center of the State where productive The sand was originally correlated with the Clinton formation of New York but it is now considered to be older It outcrops in the extreme south western corner of the State where it is barren, but it lies so low in the eastern part of the State that it has not been reached by the deepest borings The wells from this sand have furnished first gas and then oil the latter sometimes being of remarkable clearness and purity Explorations are now in progress looking toward the extension of the oil producing territory toward the north central part of the State

This paper was followed by a valuable contribution entitled Notes on the Geological Relations of Oil Pools Situated in Regions of Monoclinal Structure by Dr Frederick G Clapp of Pittsburgh Pa The author said in part Particular reference is made to the oil pools of southeastern Ohio which may nearly all be classified as situated on monoclinal structures Geologists and oil men have generally assumed that geological structure was of little assistance in predicting the positions of pools of this class The main object of this paper is to show that geology is of great value in this as in other classes of oil fields and that good predictions may be made The detailed structures of several well known oil pools are given as examples It has been discovered that in the great majority of cases the oil has accumulated at positions where the change in rate of dip is commonly proportional to the abnormality of the generally uniform dip The positions of accumulation are also influenced by structural ravines crossing the sand Although the structure of the sand may be quite different from that of the surface formations it can nevertheless be calculated to a considerable degree of accuracy from the surface by taking into account the change in intervals which is comparatively uniform for a given locality

Metal mining was not entirely overlooked on the programme and an interesting paper by Professor Frank R Van Horn of the Case School of Applied Sciences Cleveland Ohio dealt with The Occurence of Silver Copper and Lead Ores at the Vota Rica Mine Sierra Mojada Coahuila Mexico The author said in abstract These ores occur on the contact or a short distance below the contact of an acid breccia with an underlying limestone of Cretaceous age There are some indications of a fault plane between the two rocks such as clay selvages and slickensides There are two types of ore a silver lead and a silver copper series In the former group the minerals are all oxidized and consist chiefly of argentiferous cerussite along with native sulphur and some gypsum The bulk of the ores from this mine however seems to belong to the silver copper group and contains sulphides as well as oxidized minerals Minerals noticed here were chalcopyrite chalcocite covellite along with native copper malachite azurite cuprite and gypsum Another zone consisted of a siliceous limestone containing up to 10 per cent of barite which was impregnated with cerargyrite and native silver Here the copper content was smaller, and rarely exceeded 2 per cent Some three years ago a fault was discovered in the northern part of this silver-lime ore body Along this fault plane, silver and copper minerals of great richness were found mixed with more or less barite Some of the minerals noticed were native silver argentite, proustite, and pearceite, which has been found in but two or three localities in the world At this point a mixture of erythrite and barite was also noticed which seems to be the first observation of cobalt minerals in the district.

Turning to the glacial and physiographic section of geology there were several papers of considerable local interest, and others of wider bearing Among the latter may be mentioned one by Dr William C Alden of the United States Geological Survey upon Radiation of Glacial Flow as a Factor in Drumlin Formation There is a very notable development of drumlins in central eastern Wisconsin These are grouped in three more or less distinct sets corresponding to each of which there is a set of marginal moraines which are believed to mark the limits of the glacial lobe during the stages when the drumlins were being formed The outer moraine of each set marks the limit of the re-advance of the ice after an interval of recession The drumlin belts and moraines show that the ice was radiating widely to the curved margin of the lobe where it became thin in consequence of the radial spreading and of the loss by melting and ablation Computations show that the spreading of the ice under its own weight alone would not account for its remarkable expansion Hence only the forward crowding of the more rapidly moving ice at the rear (north) could have supplied the requisite volume Though the stream expanded greatly so that friction was much increased the remarkable development of drumlins indicates that the basal ice did not clog Such basal movement was probably due to the ice being shoved bodily forward by the vigorously advancing ice in the rear this forward shove being superimposed on such internal flowage as was taking place It is believed that the application of such propulsive force in the region of the center of radiation of such as mass which was tending to lag in every part owing to great friction would tend to cause the longitudinal lines of flowage to spread and so develop stress along transverse lines These stresses though perhaps not causing the actual opening of longitudinal crevasses would facilitate spreading of the ice about obstructing piles of drift and their being shaped into drumlins rather than their obliteration by erosion It might also induce localized deposition in piles or ridges which would later be shaped and might be added to by the plastering on of drift. Computations based on the ice stream forming the second set of drumlins show the radiation to have been even more marked than in the first case with corresponding greater crowding forward of the faster moving ice in the rear and more marked development of drumlins Comparison with segments of the glacier which had equal initial widths but did not form drumlins shows that in the latter there was very moderate radiation and that unless the ice in the rear was moving more slowly than in front there was a decrease in the volume of the stream as it advanced as opposed to the increase in volume of the spreading of the ice under its own weight and with no forward crowding of the ice in mass there would be absence of lateral stress and of the tendency to longitudinal crevassing, and this may explain the absence of drumlins Other factors than radiation are probably also involved

Prof Lawrence Martin of the University of Wisconsin, in a paper on "The Glaciers of Alaska" spoke in part as follows, Among the glaciers studied by the National Geographic Society's Alaskan expedition of 1910 are two of unusual activity. Columbia glacier, in Prince William Sound, Alaska, began to advance in 1908, and has been visited on July 15th, 1908, June 24th and August 22d, 1909, June 30th, and September 5th, 1910, during which time its front has been progressing at an undetermined rate where tidal, but on an island and at the borders at the rate of from 0 9 to 2.1 feet a day, destroying forests and peat bogs and modifying marginal drainage and marine deposits Childs glacier on Copper River was advancing at about its normal rate in August, 1909, the ice melting or discharging as icebergs into Copper River sufficiently fast so that the front remained nearly stationary During the winter of 1909-1910 the rate of motion increased, a previously stagnant, shrub-covered part of the margin visibly advancing into the forest at the rate of 2 to 8 feet a day during June to October, 1910 when it was re-mapped at frequent intervals Independently of this increased rate of advance the position of the ice front in the river has oscillated during the summer with the stages of water in Copper River A $1,400,000 steel bridge and the key to a railway system is threatened by this advance

The social side of these gatherings is not its least important, and there were many conferences among the guests which were held more or less in private, the subjects of which were not entered upon the programme

The Paleontological Society a daughter of the Geological Society held its meetings on the 28th and 29th of December They were attended by audiences that were highly satisfactory in point of number and as to personnel The papers delivered were decidedly technical in character and they covered a wide range of topics under the general subject of paleontology A second related society, the Association of American Geographers began its sessions on the 29th and kept many men in Pittsburgh during the remainder of the week The Association of State Geologists likewise held its annual meeting during the week

Thursday evening by invitation of the authorities of the Carnegie Institute the members of all three societies participated in an informal smoker at the Hotel Schenley at the close of the delivery of the presidential address by Dr Arnold Hague of the Geological Society

Wednesday evening was devoted to the annual dinner of the Geological Society, which was presided over at first by Dr Hague and was concluded under the leadership of Prof James F Kemp as toastmaster The reports of the officers showed a good condition of the society and there are many applicants for membership The society lost seven members by death during the past year and there are now 328 active members and 13 foreign correspondents. The election resulted in the choosing of Prof William M Davis of Harvard University as president, Prof William N Rice of Wesleyan University as vice president, Dr E O Hovey of the American Museum of Natural History as secretary Prof William Bullock Clark of Johns Hopkins University as treasurer, Mr J Stanley Brown of New York city as editor and Prof H P Cushing of Western Reserve University as librarian for the year 1911

The next meeting of the society is to be held at Washington D C in connection with the annual convention of the American Association for the Advancement of Science

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The Light of the Sky

YNTEMA has made a series of investigations of the brightness of the sky which may be summarized as follows On some nights when there is no visible moon or aurora and the sun is more than 18 degrees below the horizon the sky whether clear or cloudy is distinctly luminous as a whole or in parts The brightness of the sky which usually increases toward the horizon is sometimes equal to that of the diffused light of the half moon Printed letters and the figures of a watch can be read with ease and comparatively small objects at considerable distances can be seen—telegraph poles more than 300 feet away for example If the sky on these nights is clear it appears white or pale blue so that the Milky Way can scarcely be distinguished On the other hand there are clear nights when the sky appears almost black

The brightness of the sky cannot be caused by the stars alone for in this case it would be the same every night and would not increase toward the horizon, but would rather be diminished there by atmospheric absorption The variation in the light of the sky suggests a terrestrial cause Only a very small fraction of the luminosity can be explained by dispersion of light in the atmosphere as is proved both by theory and by experiment Yntema assumes that the earth is always surrounded by an aurora, which illuminates the entire sky to a greater or less degree It is well known that the characteristic green line of the aurora often appears in the spectrum of the sky light even when no aurora is visible to the naked eye

Primitive Vaccination

THE November issue of Hygiela the circular of the International Hygienic Exhibition which is to be held in Dresden next year, states that vaccination or inoculation which is commonly regarded as a triumph of modern medical science has long been practised by the civilized races of Asia, and even by African and other savages probably as a result of Asiatic influence We first meet inoculation for smallpox among the Chinese Lockhart gives the following quotation from an old Chinese manuscript, which was probably written early in the 11th century The ancients possessed the knowledge of inoculation for smallpox. It has come down to us from the reign of Chin tsung of the Ting dynasty and was discovered by a philosopher When the disease breaks out spontaneously it is very serious and often fatal but when it is produced by inoculation it is usually mild and does not cause more than one death in ten thousand cases" In Persia inoculation is accomplished by scratching the forearm and rubbing into the slight wound after bleeding has ceased the pulverized scurf which falls from a smallpox patient The Ashantee negroes, according to Bowditch, inoculate in seven places on the arms and legs. The Moors practise the same method The Siamese have the peculiar custom of blowing the scurf into the nose An interesting collections of material illustrating this subject will be shown at the Dresden exhibition

An interesting sidelight on Chinese railways is contained in the report of Mr Pitzipios, British consul at Chingkiang A proposal was made to have a railway from Kuacheu, at the mouth of the Grand Canal, to Hsü Chou Fu Owing, however, to the indifference of the wealthy men of Yangchow and other places, the necessary capital could not be subscribed. One wealthy and influential Chinese gentleman of Chingkiang worked hard to secure funds, but met with rebuffs in all directions. Curiously enough, during the later months of 1909 a well-printed leaflet, bearing a rhyming song exhorting people to subscribe capital to build this railway, was freely distributed among the Chinese The gist of it was to the effect that the trade of Chingkiang would suffer by the completion of the Tientsin-Pukow Railway, and that the Kua-Hsü Railway was the only thing to save the situation. All were, therefore, urged to buy shares at $5 each, payable at the rate of $1.25 a year The exhortation included women and children, artisans, and coolies, and the present value of the Pekin-Hankow Railway shares was put forward as an incentive.

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Wool scouring P Schmid 981,[illegible]
Wool washing machine F G Sargent 981,1[illegible]
Work bench A W Richards 981,11[illegible]
Work holder J A De Bord 980,[illegible]
Wrench J F Wright 981,[illegible]
Wrench Bombiatus & Caviola 981,53[illegible]
X ray apparatus W S Fullerton 981,[illegible]

A printed copy of the specification and drawing of any patent in the foregoing list or any patent in print issued since October 4th 1859 will be furnished from this office for 10 cents provided the name and number of the patent desired and the date be given. Address Munn & Co. Inc. 361 Broadway New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list For terms and further particulars address Munn & Co Inc 361 Broadway New York

Aeronautical Notes

The Winner of the Paris Brussels Race—Herr Wynmalen the Dutch aviator captured the $20 000 prize for his flight from Paris to Brussels and back with a passenger in less than 36 hours on October 16th and 17th 1910 Eleven attempts were made by leading aviators but with the exception of Wynmalen none was successful Legagneux with Martinet as passenger reached Brussels in record time on November 13th but he was unable to return to Paris on account of the heavy wind This was the second time he had made the flight one way

Death of France's Oldest Lady Aeronaut—Close upon the death of Octave Chanute in this country comes news of the death in France of her oldest woman aeronaut Mme Dozeville who recently died at the age of 7[illegible] years was a sister of Louis Godard the well known balloon and airship constructor From 1865 to 1867 the then Eugenie Godard made numerous free ascents with her brothers Eugene Louis and Jules and also a great number of parachute drops

The Coupe Fémina and Other French Prizes—The last day of the old year aviatress Jane Herveu the fifth French woman to receive an aeroplane pilot's license attempted to beat Helene Dutrieu's record of 105 miles in 2 3[illegible] made on December 21st last for the Coupe Fémina She only succeeded in flying 90 miles in 2 hours in her Blériot monoplane however—Lieut Cammerman is the winner of the Weiller military prize of $5 000 He flew 232 kilometers (144 15 miles) with a passenger in 4 03 04 on December 21st Lieut Caumont while trying a Nieuport monoplane before competing for this prize lost his life at Buc on December 30th The Duperdussin $5 000 cup for the quickest 100 kilometers (62 1 miles) flown with a passenger before the end of 1910 was won by Laurens on a R E P monoplane on December 21st His time was 1 16 05 which beats by 20 minutes Aubrun's record at Rheims and corresponds to an average speed of 48⅓ miles an hour

The Baron De Forest Prize—The prize of £4 000 given by Baron De Forest mentioned below was won by Thomas Sopwith by his flight on December 18th of 169 miles from the Isle of Sheppey England across the Channel to Beaumont, Belgium Sopwith had a favorable wind He crossed the Channel in record time and completed the flight in 3½ hours averaging about 50 miles an hour He used a Howard Wright biplane fitted with an eight cylinder E N V motor Later on December 22nd Cecil Grace flew across the Channel and back again in his own Farman type machine but lost his bearings and turned out to sea when within five miles of the English shore As his cap was picked up a fortnight later he undoubtedly perished

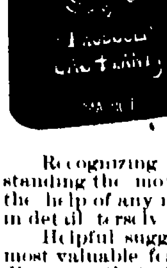
New Records for Michelin Trophy—On December 30th last Maurice Tabuteau won the French Michelin Trophy for 1910 by a flight lasting 7 48 31 3/5 in which he covered 363 46 miles Henry Farman attempted to beat this record the next day but he was unsuccessful He covered 302 6 miles in 7 hours 11 minutes time In England Capt Cody covered 185½ miles in 4 hours 47 minutes thereby winning the English Michelin Trophy and special prize In France four other attempts to win the Michelin Trophy were made upon December 31st Marie cov ered 329 miles in an R E P monoplane at Buc Breguet and Sommer flew 242½ and 109 miles on their respective biplanes while in the United States near New Orleans John B Moisant America's foremost aviator was pitched from his machine and killed when about to compete for the Michelin Trophy

Flight Across the Rio-de-la Plata—At Buenos Ayres on December 17th last Cattaneo succeeded in flying across the Rio-de la Plata a distance of 34 miles over the course followed The Italian aviator was 2 hours and 35 minutes making the passage owing to an extremely heavy head wind He eventually brought his Blériot safely to earth at Colonia and was awarded the $20 000 cash prize that had been put up for this flight—a flight much less difficult than that from Paris to Brussels and back with a passenger and for which a prize of the same amount (100 000 francs) was given Baron De Forest, of England also gave a prize of this amount for the English built aeroplane piloted by an Englishman that should fly across the Channel and travel the longest distance into Belgium before the end of the year 1910

The Wind and Aviation Above the Sahara—It has been asserted that one of the chief obstacles to flying above the Sahara desert for utilitarian purposes such as the carrying of mail and the like was the violence of the wind But on this point some very precise and almost conclusive information has recently been obtained by the National Aerial League of France This information comes from Capt. Boué chief of the geodetic brigade of the Tuniso-Tripolitan frontier During last October Capt Boué with the aid of a Daloz anemometer which the league presented to him observed the direction and velocity of the wind from Gabes to Djenefen going via Kethana Medonine and Tataouine During this month three entire days passed without any wind whatever and never except sometimes when there were gusts (only one of which showed a velocity of 20 meters per second—53¾ miles an hour—during two or three seconds) did the velocity of the wind exceed 12 meters per second (26¼ miles per hour) The daily average was but 4 4 meters per second (9 62 miles per hour) These observations are extremely encouraging since they show that apart from the single day perhaps when the sacred sirocco was blowing an aeroplane could easily have flown every day during at least eight hours out of twelve

According to the Railway Gazette the Prussian State Railways Administration has been moved apparently by a recent accident when signals were not observed to issue new orders regarding the inspection of signals Every year the officer in charge of trains the officer in charge of signals and an engineman selected for his experience and familiarity with the part of the line to be inspected are to go over the road on a locomotive but only two of them at a time on engines hauling trains They are to pay particular attention to the following points (A) The visibility of the signals—their background their obscuration by telegraph poles station buildings trees etc the effect on night signals of arc lights in the vicinity or the reflection of other signals, the condition of the signal glasses (B) The distance of the signal from the danger point (C) The grouping of signals where several stand near each other in one row or other wise the appearance of the signal from every position in succession the possibility of the confusion of signals (D) The substitution for signals standing left of the main track of signals on the right of the track (E) Substitution of high distant signals for low signals (F) Superfluous signals (G) The proper designation of main and branch tracks, where one post has several signals If all these points be attended to, the signaling installation should be all right

Modern Gas Engines and Producer Gas Plants



By R. E. Mathot, M. E.

8vo.; 314 pages, 152 illustrations; Price, $2.50 postpaid.

THIS is a practical treatise, setting forth the principles of gas engine and producer design the selection and installation of an engine, conditions of perfect operation producer gas engines and their possibilities, the care of gas engines and producer gas plants, with a chapter on volatile hydrocarbon and oil engines. A guide for the gas engine designer user and engineer in the construction selection purchase, installation operation and maintenance of gas engines.

Recognizing the need of a volume that would assist the gas engine user in thoroughly understanding the motor upon which he depends for power the author has discussed his subject without the help of any mathematics or theoretical explanations Every part of the gas engine is described in detail tersely clearly and with a thorough understanding of the requirements of the mechanic Helpful suggestions as to the purchase of an engine etc installation, care and operation form a most valuable feature of the work Each chapter is profusely illustrated with carefully prepared diagrams that elucidate the explanations of the text Thoroughly modern in the treatment of the subject the work discusses at considerable length the generation of producer gas and its utilization

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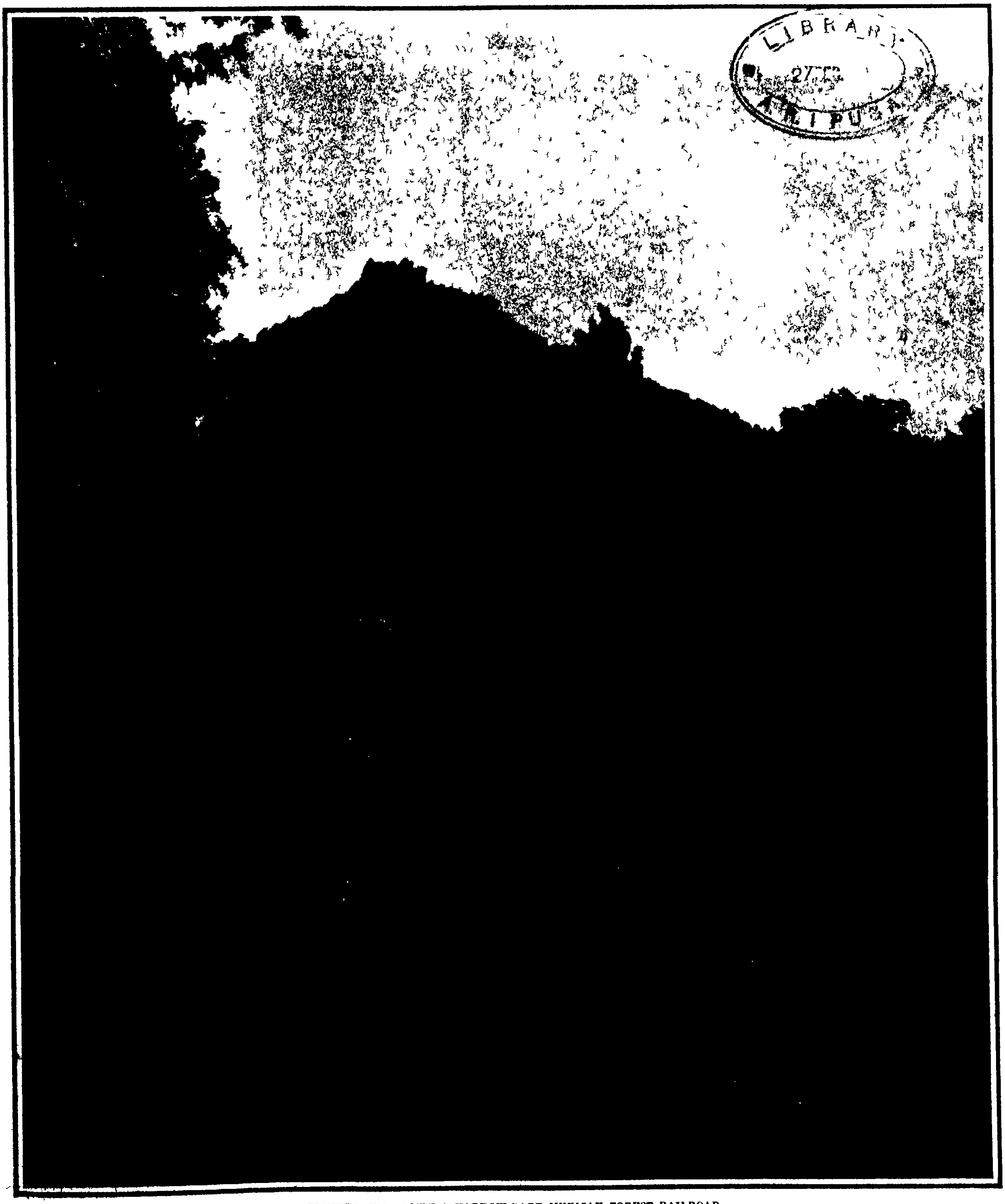


LIBRARY

A PIONEER TRIP DOWN A NARROW-GAGE MEXICAN FOREST RAILROAD

AMERICAN FOREST RAILWAYS.—[SEE PAGE 56.]

What Electrochemistry is Accomplishing—I*

Modern Methods and their Results

By Joseph W Richards

My theme is to depict for you as clearly as I may be able the part which electrochemistry is playing in modern industrial processes I have no exhaustive catalogue of electrochemical processes to present nor columns of statistics of these industries but my object will be to classify the various activities of electrochemists and to analyze the scope of the electrochemical industries And since electrochemical industries have developed in almost all parts of the world except Pittsburg I will endeavor to bring to your view by means of pictures taken from actual photographs of plants in operation the reality of the large and important electrochemical industries

SCOPE OF ELECTROCHEMISTRY AND ELECTROMETALLURGY

Chemistry is the science which investigates the composition of substances and studies changes of composition and reactions of substances upon each other As an applied science it deals chiefly with the working over of crude natural material and its conversion into more valuable and more useful substances

Some common examples illustrate this statement are the conversion of native sulphur into sulphuric acid the manufacture of soda and hydrochloric acid from common salt the conversion of phosphate rock into superphosphate fertilizer etc etc Several pages would not suffice to merely catalogue the great variety of chemical industries immense amounts of capital are invested in them and they are some of the most fundamental industries in their relation to supplying the needs of a rapidly advancing civilization

Metallurgy is the art of extracting metals from their ores and of purifying or refining them to the quality required by the metal working industries It is a branch of applied chemistry The metallurgical industries form a highly important part of our national resources on them we depend for iron steel copper brass gold silver lead zinc aluminium etc in fact for all the supply of metals used in arts and industry

Electrochemistry is the art of applying electrical energy to facilitating the work of the chemist It is chemistry helped by electricity It is the use of a new agency in accomplishing chemical operations and it has not only succeeded in facilitating many of the most difficult and costly of chemical reactions but it has in many cases supplanted them by quick simple and direct methods it has even in many cases developed new reactions and produced new materials which are not otherwise capable of being made A few examples will illustrate these points Caustic soda and bleaching powder are made from common salt by a series of operations but the electrical method does this neatly and cheaply in practically one operation lime and carbon do not react by ordinary chemical processes but in the electric furnace they react at once to form the valuable and familiar calcium carbide carbon stays carbon except when the intense heat of the electric furnace converts it into artificial graphite The list of such operations is a long one and it may be said that the chemist has become a much more highly efficient and accomplished chemist since he became an electrochemist, and he is becoming more of an electrochemist daily

Electrometallurgy applies electric energy to facilitating the solution of the problems confronting the metallurgist Its birth is but recent yet it has rendered invaluable service It has made easy some of the most difficult extractions has produced several of the metals at a small fraction of their former cost and has put at our disposal in commercial quantities and at practicable prices metals which were formerly unknown or else mere chemical curiosities It has further refined many metals to a degree of purity not previously known The metallurgist is rapidly appreciating the possibilities of electrometallurgical methods and they already form a considerable proportion of present metallurgical practice

Applied electrochemistry covering in general all of the field just described is therefore an important part of chemistry and metallurgy and is rapidly increasing in importance It is a new art people are really only beginning to understand its principles and to appreciate its possibilities it is an art pursued by the most energetic and enterprising chemists with the assistance of the most skilled electricians Some of its most prominent exponents are electrical engineers who have been attracted by the vast possibilities opened up by these applications of electricity The chemists have worked with electricity like children with a new toy or a boy with a new machine they have had the novel experience of seeing what wonders their newly applied agency could accomplish and it is no exaggeration to say that they have astonished the world—and themselves

THE AGENTS OF ELECTROCHEMISTRY

The operating agent in electrochemistry is of course electric energy which may be used in three classes of apparatus viz

(I) Electrolytic Apparatus.
(II) Electric Arcs and Discharges in Gases
(III) Electric Furnaces

I Electrolytic Apparatus

Electrolytic apparatus and processes use or utilize the separating or decomposing power of the electric current Whenever an electric current is sent through a liquid material which is compound in its nature i e a chemical compound the current tends to decompose the compound into two constituents appearing respectively at the two points of contact of the electric conducting circuit with the liquid in question i e at the surface or face of contact of the undecomposable conducting part of the circuit with the decomposable part If the current has a definite direction the constituents appear at definite electrodes The action is simply the result of the current extracting or tending to extract) from the electrolyte *one of its constituents at each of the two electrode surfaces* All subsequent changes following upon this primary tendency of the current are called secondary reactions and are practically simultaneous with the primary These may even be regarded as truly primary reactions also the primitive decomposing or separating power of the current passing being regarded only as a *tendency* or a *determining* cause which practically results in the reactions actually taking place

This agency is an extremely vigorous and potent force for producing chemical transformations It enables us for instance to split up some of the strongest chemical compounds into their elementary constituents to convert cheap materials in short to perform easily some very difficult chemical operations and in some cases to perform chemical operations otherwise impossible A description of all these various processes would take a volume but a short explanation of a few of them will make the principles clear and suffice for my present purpose

Electrolysis of Water As a raw material water may be said to cost nothing Apply an electric current to it in the proper way and it is resolved into its constituent gases hydrogen and oxygen as cleanly and perfectly as anyone could desire These gases have many and various uses and are valued each at several cents per pound A whole industry has thus grown up based on the simple electrolysis of water to supply these two gases for various industrial uses. Europe possesses many of these plants there are a few in the United States The speaker has translated from the German a small treatise on this industry

Electrolysis of Salt Common salt sodium chloride is one of the cheapest of natural chemicals It has some uses of its own, but centuries ago chemists and even alchemists devised chemical processes for transforming it into other sodium salts, such as caustic soda or soda lye for use in soap soda ash or carbonate for washing or glassmaking and into chlorine bleaching materials Chemical works operating these rather complicated chemical processes exist on an immense scale in all civilized countries it is estimated that \$50 000 000 is thus invested in Great Britain alone The electrolytic alkali industry is barely twenty years old yet it is already more than holding its own with the older chemical process and advancing rapidly twenty years more will probably see the older processes entirely superseded—they are at present fighting for their existence As for the electrolytic process the salt is simply dissolved in water and by the action of the current converted into caustic soda at one electrode and chlorine gas at the other By some special devices these are kept separate and collected by them selves and the work is done The principles involved are simplicity itself as compared with the older chemical processes, the only agent consumed is electric energy and the products are clean and pure

Chlorates These are salts used on matches and in gunpowder Chlorate of potassium is a valuable salt with important uses It is made from common cheap potassium chloride, in solution in water, by simply electrolysing the solution without trying to separate the products forming at the electrodes. It is a simpler operation than the production of electrolytic alkali. Chlorate thus forms in the warm *solution and is obtained by letting the solution cool* and the chlorate crystallise out. The ordinary chemical manufacture of this salt was tedious and dangerous the electrolytic method has practically entirely superseded it.

Perchlorates These salts have more limited uses, but are made by expensive chemical methods. The electrolysis of a chlorate solution at a low temperature without separating the products formed at the two electrodes results in the direct and easy production of perchlorates I cite this more to illustrate what I might call the versatility of electrochemical methods rather than because of its commercial importance

Metallic Sodium The caustic soda produced from salt can itself be electrolytically decomposed this is the easiest way of producing metallic sodium. Sir Humphry Davy discovered sodium by electrolysing melted caustic soda and at this moment several large works are working this method on an immense scale The caustic contains sodium hydrogen and oxygen and the current simply liberates the sodium as a molten metal and frees the other two as gases, which escape into the air The process is simplicity itself—when the exact conditions are known and rigidly adhered to Metallic sodium is a very useful material to the chemist and the electrolytic method produces it at probably *one-fourth* the cost of *making it in* any purely chemical way

Magnesium This is a wonderfully light metal whose chief use is in flash-light powders Its compounds are abundant in nature but its manufacture by any other than the electrolytic method is almost impracticable The operation consists in simply passing the decomposing current through a fused magnesium salt—a chloride of magnesium and potassium found in abundance in Germany

Aluminium The most useful of the light metals an element more abundant in nature than iron yet which costs by chemical methods at least \$1 00 per pound to produce electrochemistry enables the makers to sell it at a profit at \$0 25 per pound. This is probably the most useful metal given to the world by electrochemistry Although the French chemist Deville obtained it by an electrolytic method in 1855 yet he had only the battery as a source of electric current and the process was too costly This very city of Pittsburg was the real cradle of the electrolytic manufacture of aluminium when in 1889 Mr Chas M Hall with the financial assistance of the Mellons and the business assistance of Capt A E Hunt commenced to work his process up at Thirty-third Street on the West Side The principle of the process is here again one of beautiful simplicity—when it is once made known Aluminium oxide abundant in nature is infusible in ordinary furnaces but easily melts and dissolves, like sugar in water in certain very stable and liquid fused salts—double fluorides of aluminium and the alkali metals On passing the electric current through this bath the dissolved aluminium oxide is decomposed appearing at the two electrodes as aluminium and oxygen respectively When all the oxide is thus broken up more is added and the operation continues One of the most difficult problems of ordinary chemistry is thus simply neatly and effectively solved by electrochemistry The lower cost of power at Niagara Falls drew the industry away from Pittsburg in 1893 and it is now run on an immense scale at several places where water power is cheap and abundant Mechanical power is however being produced cheaper every year gas engines have halved the cost of such power steam turbines on exhaust steam may even do better there is no inherent impossibility in the return of the aluminium industry to the Pittsburg district. Many other factors besides cost of power bear on the question cost of labor abundance of labor cost of carbon coal for heating various supplies railroad freights nearness to the consumers and many other considerations must be taken into account. Aluminium is certainly destined to become the most important metal next to iron and steel and as far as one can now foresee will always be produced electrochemically To have accomplished the establishment of this one single industry would itself have proved the usefulness of electrical methods and their importance to chemistry and metallurgy

Refining of Metals; Unless metals are of high purity they are usually of very little usefulness in electrolytic methods enable almost perfect purity to be easily attained and in addition permit the separation at the same time of the valuable gold and silver contained in small amount in the baser metals. These

* An address delivered at the Seventeenth General Meeting of the American Electrochemical Society in Pittsburg Pa. and printed in the Transactions of the Society

[illegible],000 000 worth of copper is electrically refined every year in the United States, the metal produced is purer than can be otherwise obtained giving the electrical engineer the highest grade of conducting metal, while several million dollars worth of gold and silver are recovered which would otherwise have to be allowed to remain in the copper Again the method is so simple that but a few words are necessary to set it forth in principle The impure copper is used as one electrode—the anode—in a solution of copper sulphate containing some sulphuric acid the receiving electrode—the cathode—is a thin sheet of pure copper or of lead greased The electric action causes pure copper only to deposit upon the cathode, if a properly regulated current is used while a corresponding amount of metal is dissolved from the anode Silver gold and platinum are undissolved and remain as mud or sediment in the bottom of the bath other impurities may go into the solution but are not deposited on the cathode if the current is kept low The cost of this operation is small and the results are so highly satisfactory that 90 per cent of all the copper produced is thus refined Similar methods are in use for refining other metals silver gold and lead are thus refined on a large scale antimony bismuth tin platinum zinc and even iron can be thus refined the field is very inviting to the experimenter and to the technologist and is rapidly increasing in industrial importance

Metal Plating All electro-plating is done by the use of electrolytic methods similar to those just described If we imagine the impure metal anode replaced by pure metal and the receiving cathode to be the object to be electro-plated we have before us the electro-plating bath ready for action Everybody knows the value and use of gold silver and nickel plating less well known are platinum cadmium chromium zinc brass and bronze plating These are among the oldest of the electrochemical industries Electrotyping is only a variation of this work also the electrolytic reproduction of medals engravings cuts etc and even the production of metallic articles of various and complicated forms such as tubes needles mirrors vases statues etc There is opportunity here to hardly more than catalogue these various branches of electrometallurgical activity Pittsburg people will be interested however in knowing that many of the newer buildings in this city contain thousands of feet of electrical conduits zinc plated in splendid fashion by electrolysis at a works within a few miles of this city At McKeesport tubes are coated by dipping into melted zinc on an immense scale but the electrolytic method is gaining a foothold and we may live to see all galvanizing in reality practised as it is spelled The removing of metallic tin from waste tin scrap is also accomplished on a large scale by the application of similar principles It is being operated at a distance from Pittsburg but your open hearth furnaces use up annually thousands of tons of the scrap steel thus cleaned and saved for remanufacture into useful shape

Without having mentioned or described more than a fraction of the electrolytic methods in actual industrial use I hope that I have made clear the importance and extent of this kind of electrochemical processes Assuming this we will pass to the consideration of another entirely different and yet important class of apparatus and processes

II Electric Arcs and Discharges in Gases

Electric arcs and high tension discharges through gases are capable of producing some chemical compositions and decompositions which are very useful and profitable to operate This is a branch of electrochemistry which has not been as thoroughly studied as some others its phenomena are not as thoroughly under control as electrolysis and electro-thermal reactions and its possibilities are not as thoroughly understood or utilized

Ozone is being made from air by the silent discharge of high tension electric current The apparatus is so far simplified as to be made in small units suitable for household use ready to attach to a low tension alternating current supply The uses for the ozone thus produced are particularly for purifying water and air it makes very impure water perfectly safe to drink and purifies the air of assembly halls and sick rooms acting as an antiseptic According to all appearances this electrochemical doubling up of oxygen into a more efficient oxidizing form is developing into a simple and highly efficient aid to healthy living

Nitric Acid is an expensive acid made from the natural alkaline nitrate salts such as Chili saltpeter These nitrates are the salvation of the agriculturist for they furnish the ground with the necessary nitrogen which plants can assimilate The Chili nitrate kings have gained many millions of dollars even hundreds of millions in thus supplying the world's demand for fertilizer But electrochemistry has another solution to this problem which is rapidly rendering every country which adopts it independent of the foreign fertilizer The air we breathe contains uncombined nitrogen and oxygen gases which if combined and brought into contact with water furnish the exact constituents of nitric acid The way to do this has been laboriously worked out and the electric arc is the agent which does it Air is simply blown into the electric arc where it for an instant partakes of the enormous temperature and on leaving the arc is cooled as quickly as possible In the arc the combination of nitrogen and oxygen is effected to a certain extent and the mixture is cooled so suddenly that it does not find time to disunite The nitrogen oxides thus obtained are drawn through water and this solution of nitric acid is run upon soda to produce sodium nitrate or on lime to produce calcium nitrate the latter called nitro lime or Norwegian saltpeter These salts entirely replace the South American natural salt

The materials used in this industry are air and lime and to these is added electrical energy Air is universal lime cheap almost everywhere and electrical energy is cheapest where water powers are most abundant In Norway water power can be developed and electrical energy supplied from it at a total cost of $4 00 to $8 00 per horse power year Some other countries can do nearly as well Under these conditions almost every country can afford to make its own nitrates and so be independent of other countries for the fertilizer needed in peace and the gunpowder used in war Norway felicitates itself already on being thus independent nearly 200 000 horse power is being utilized there by a $1[illegible] 000 000 syndicate and the industry is spreading rapidly over Europe The study of this problem its solution and the rapid development of this vigorous industry is one of the most remarkable chapters in the history of recent industrial development In this accomplishment electrochemistry has signally aided the agriculturist and demonstrably multiplied the food supply resources of all civilized and highly populated countries

Boron is an element which has until recently defied the best efforts of chemists to isolate in a pure state It is an element which may have important application in the manufacture of a high class special steel—boron steel Dr Weintraub one of our fellow members has recently solved the problem of its production by an adaptation of the oxygen nitrogen arc apparatus and utilizing the same principle of introducing the material into the arc and very rapidly cooling the products obtained We mention this not because of its great commercial importance at present but because it shows how the arc method may be of wide application in solving other difficult chemical problems It has opened before us a new method in chemical science and may give birth to many and various new chemical industries

(To be continued)

The Question of Exercise

WHY should men whose natural physical endowment was always above par and who have been famous for their powers—gridiron stars crack oars men sturdy tug o wars men record makers in field sports—succumb to maladies which their weaker brothers readily conquer? It cannot be fairly assumed that the type of disease was so much graver in their cases We must look to other causes than this and the heart tells us why That organ had long been overtaxed and had after years of strenuous physical effort become abnormally large and in turn become degenerate so that it could no longer be relied upon to fight a battle which it might safely have waged without the previous strain

This entire question is ably considered by Dr Albert E Sterne in his presidential address before the Ohio Valley Medical Association

During the developmental years he tells us the comparative demand made upon the heart is pretty well up to its limits all of the time for with body growth there is constantly increasing tissue formation This new tissue requires nourishment and this can be conveyed only through the circulation After what we term full growth has been reached there is relatively and actually less strain placed upon the heart so that it can more readily respond to any unusual yet reasonable demand made upon its power During the years of adolescence however while the heart is being taxed to its capacity most of the time it cannot be safely asked to do too strenuous service The growing boy or girl who complains of shortness of breath pain in the side and palpitation upon moderate or prolonged effort instances this dictum clearly Examples of this kind are so common as to require only the merest mention After the developmental period such phenomena become less frequent, even though the demand upon heart and blood vessels be considerably greater

"By means of accurate apparatus the tension to which the circulation is subjected can be measured and any increase or decrease from the normal be registered. Increase in tension, that is, force for the heart and elasticity for the arteries, means increased muscular effort and expenditure on the part of the heart. This the organ can safely give, if the demand [illegible] too great or too constant; but only then, for it must be remembered that the heart is a muscle—indeed a very powerful one and like every other muscle it adds to its intrinsic volume through use that is it becomes enlarged Once this condition becomes established the heart continues to exert undue force automatically and drives the blood too vigorously against the arterial walls to the lasting detriment of the latter which striving to maintain their normal compensatory relationship increase their own muscular coat and herewith is established an abnormal condition a true pathology a real vicious cycle Even in minor degree such a condition cannot be regarded lightly as baneful effects in after life are pretty sure to follow Lowered resistance and lessened vitality are pretty certain sequelæ In the major degrees the effects are really disastrous Here we see often excessive idiopathic hypertrophy or essential heart enlargement due wholly to the constant strain which had been placed upon that organ either at a period when it had all it could reasonably do to fulfill its normal duty or after this period has been passed by whipping it to activity beyond its potential capacity Sooner or later every hypertrophic muscle undergoes degeneration and every hypertrophic heart does the same thing Yet even if it did not the loss of elasticity of the arterial walls—the vital rubber of body tissue—would alone bring about general inanition

Purely on medical grounds therefore I am opposed to such forms of exercise for growing boys and girls especially In my opinion strenuous sports or athletics of every description which place an abnormal demand upon the circulation cannot be too emphatically condemned They should have no place at all in our grade schools intermediate or high schools public or private and be permitted only under rigid physical scrutiny even in the undergraduate classes of higher institutions of learning associations clubs or whatever they be called where the participants are not practically full grown and developed beyond the average.

In almost all of our universities and colleges medical oversight of all aspirants to athletic honors is given This is probably true also of some of our preparatory, private, and less frequently public schools But is this true of even a respectable minority? Moreover, this lack of scrutiny by competent medical authority is most apparent just where it is most essential for the growing and half grown boys and girls

Of all athletic sports doubtless football makes the greatest and most constant physical demand In minor schools it should be forbidden not merely because of accidents but chiefly because it is a sport for no weakling even though grown Football is a man's game in every sense and then only for men above physical par What what I have stated in regard to football is true I feel experience will substantiate It is a notable fact that men of powerful physique naturally who have been in their day famous athletes show a remarkable lack of resistance in later life and frequently become victims of diseases which they should have been expected safely to weather Instances of this sort have not been isolated Indeed they have occurred frequently enough to ask the reason

The Propagation of the Sound of Explosion

SOURCES of sound of great intensity are immediately surrounded by a region of normal audibility of irregular extent which is surrounded by a much larger region of abnormal audibility which in certain cases which have recently been investigated is separated from the inner region by a silent zone some 60 miles in width G von dem Borne offers the following explanation of these phenomena

In the lower strata of the atmosphere where the temperature decreases in ascending and the molecular weight of the air is sensibly constant the acoustic rays are concave above In the upper strata on the contrary they are concave below because of the greater proportion of light gases of small molecular weight in the atmosphere and the consequent increase in the velocity of sound The wind exerts only a secondary effect upon the phenomena The calculations of this scientist agree so well with the facts that the hypotheses upon which they are based particularly in regard to the composition of the air at different heights must be considered as expressing the essential truth A more profound study of the phenomenon in the case of volcanic eruptions for example might give valuable information concerning the temperature of the upper air to a height of about 60 miles and the proportions of various gases in the atmosphere

The Manufacture of Rolled "H" Beams*

A Review of Recent Practice

By G E Moore MIME

MANY inv n o s hav devo ed time and brain work to the f of he eans for man fact ring rolled beams a f a er y ars nore par icularly to the man fa ure of so a led H beams or beams hav ng flanges of great width as compared with the

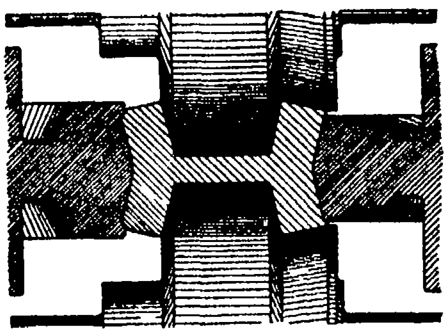


FIG 1 R HIN R LLS OPEN

height of the beam With ord nary tw or three high mills having grooved horizontal rolls only the practi cal economic limit appears to have been reached n the case of the commercial standard sections but beams of much larger section than these and more particularly beams having relatively far wider flanges are rolled more or less successively in universal mills

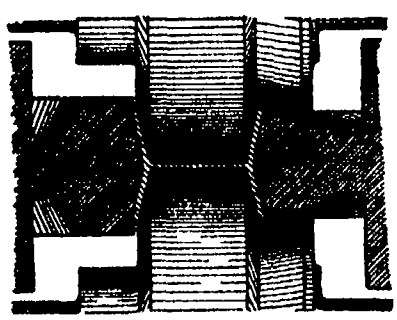


FIG 2—ROUGHING ROLLS CLOSED

which have both horizontal and vertical rolls Moreover with a universal mill a more economic distribu tion and better working up of the metal appears to be attainable than is the case with ordinary grooved rolls Using grooved rolls only the width of flanges which it is possible to roll is limited not only by the necessity of using rolls of very large diameter to ac

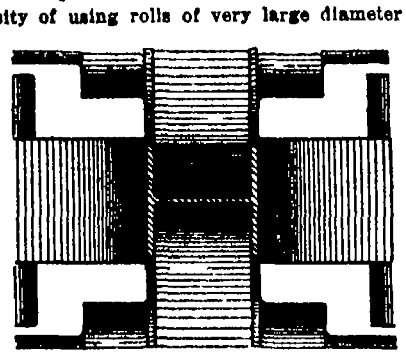


FIG —FINISHING ROLLS

commodate the deep grooves necessary to produce wide flanges and still leave sufficient metal in the rolls to give the necessary strength thereto but also by the necessity of making such grooves with a very great inclination of their sides in order to avoid the tend ency for the metal to become jammed therein which

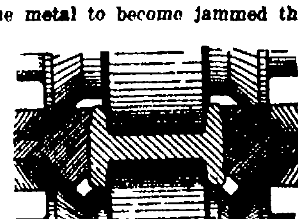


FIG 4 TWO HIGH ROLLS OPEN

results in the flanges being weakened if not torn away altogether

Universal mills aving a pair of horizontal and a pair of vertical rolls all in the same vertical plane are now in operation adapted to roll beams of much larger sizes than hitherto called for or say up o about 30 inches high by 15 inches wide But the prac-

tical difficulties which had to be overcome to insure success in the production of such sections has neces sarily involved a complication of the machinery used as compared with the mills customarily used to roll ordinary standard sections

The difficulty of working up the metal in a compli cated section such as an H beam undoubtedly is is

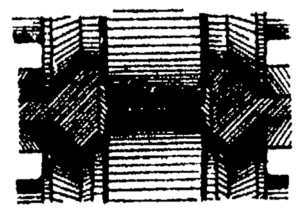


FIG 5 TW HIGH ROLLS CL SED

to secure sufficient uniformity to avoid undue internal stresses having regard to the comparative thinness of he metal in the web and flange necessary to enable them to be manufactured sufficiently cheaply to com pete commercially with built up beams Another dif ficulty is that of produ ing finished beams of suf ficiently good appearan e free from fins eccentricity of web and other irregularities These are the chief

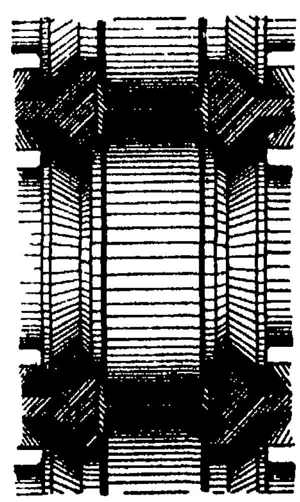


FIG 6—THREE HIGH ROLLS

points which the inventor has had to watch and to overcome which still taxes his ingenuity

In what follows the author proposes first to describe briefly a few of the characteristic types of machines disclosed by different inventors through the medium of the Patent Office of the United States of America, to offer a few remarks thereon and finally to present his own suggestions for criticism

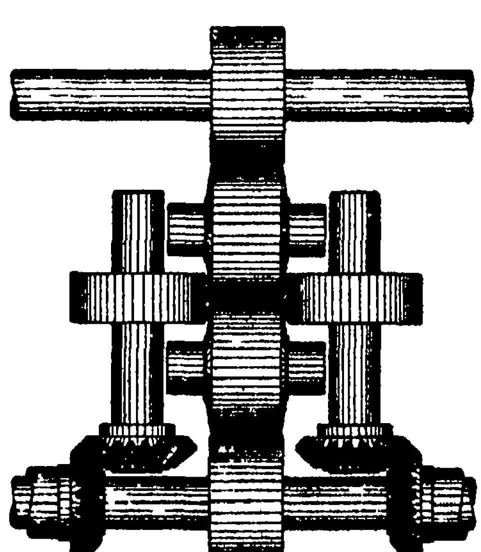


FIG 7—FIRST MILL

H Sack patent No 365100 (1887) describes a single reversing universal mill having a pair of hori zontal rolls and a pair of vertical rolls with their axes all lying in one vertical plane the two horizontal rolls being both alike but individually unsymmetrical, while the two vertical rolls are both different but in dividually symmetrical—Figs 1 and 2. Thus the gaps between the rolls are on one side at the extreme out-

side edges of the flanges and on the other side, at the extreme inside edges of the flanges. After each pass between the rolls the bar is tilted half round, and the positions of the flange edges relatively to the po-

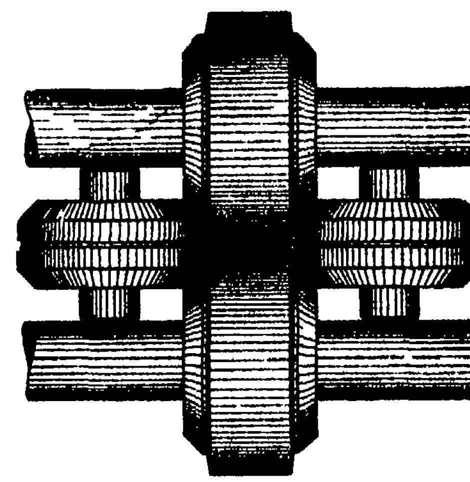


FIG 8—SECOND MILL

sition of the gaps between the rolls are reversed, and the edges which in one pass were adjacent to the gaps between the rolls are in the subsequent pass adjacent to the closed corners of the rolls In this way the surplus metal extr ded between the gaps of the rolls in one pass is rolled down and suppressed in the next.

The use of a single set of rolls for the reduction of the preliminary bar into a beam renders reversing and adjustment of the rolls after each pass necessary and it is impracticable with the rolls as described by H Sack and illustrated to have a closed pass between them At best gaps are left at the corners of the flanges which gradually become narrower as the pass is reduced and the blank rolled down until the

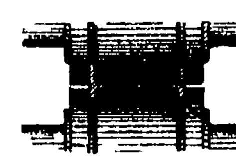


FIG 9 THIRD MILL

final adjustment is made prior to the final reduction when the gaps are reduced to a minimum Nor even at the final pass is it practicable to have an entirely closed pass because although the rolls may be ad justed prior to the final reduction so that they touch and the pass is practically closed, yet directly the bar enters the pass deflection takes place which opens out the pass and gaps are left between the rolls where fins will be formed on the bar

With this method the section is developed with flanges outwardly bent from the longitudinal center line in order to obtain a better rolling effect with the horizontal rolls upon the flanges and this feature ren ders necessary the use of a finishing set of rolls—Fig 3—through which the bar is passed after having been completely reduced in the previous set. The pass be tween these rolls need not be adjustable excepting to

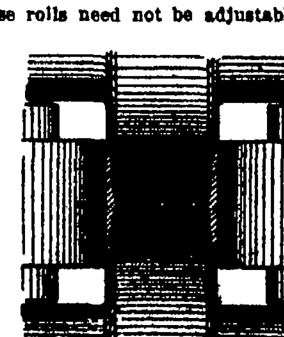


FIG 10—SINGLE REVERSING UNIVERSAL MILL

compensate for wear or displacement, and may be fixed in the ordinary way Its shape is exactly that of the section required so that the effect of passing the bar through these rolls is merely to square up the flanges and give a final finish to the bar particularly at the corners of the flanges, where traces of surplus blank metal may have been left after reduction in the previ ous mill. No appreciable reduction need be given to

* Iron and Steel Institute.

[illegible] the finishing rolls and, consequently, no [illegible] deflection of the rolls takes place when the bar is passed through them the pass, therefore remains practically closed and the formation of fins on the finished bar is avoided

J. [illegible] patent No 400 495 (1889) describes a single reversing universal mill having a pair of horizontal rolls and a pair of vertical rolls with their axes all lying in one vertical plane the two horizontal rolls being unlike each other but individually symmetrical, while two vertical rollers are both alike but individually unsymmetrical—Figs 4 and 5 Thus as in the [illegible] mill the positions of the flange edges are changed relatively to the gaps between the rolls by tilting the bar half round after each pass and thereby rolling down in one pass the surplus metal extruded between the gaps in the rolls in the previous pass. Or he proposes to attain the same result

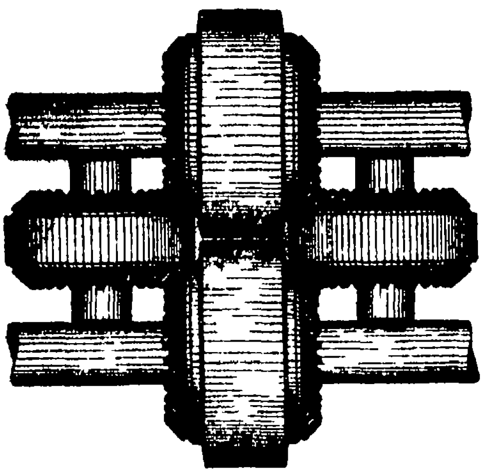


Fig 11 —NON REVERSING UNIVERSAL MILL

without tilting by using a three-high universal mill having rolls of exactly similar construction to those described above but with the top and bottom rolls alike and the center roll different—Fig 6

In this mill the bar is developed with straight flanges lying in a plane at right angles to the web so that no subsequent straightening is required and the bar may be finished in the one mill only

J Kennedy and H Aiken patent No 410 107 (1889) describe a series of mills comprising three different types each having a function distinct from that of the others

The first is a reversing roughing universal mill having adjustable horizontal and vertical rolls with their axes all lying in one vertical plane—Fig 7 In this it is proposed to reduce the ingot or bloom into approximately the finished form of beam required by passing it several times backward and forward through the rolls and adjusting the last together after each pass When the bar emerges finally from the mill the sides and edges of the flanges are still

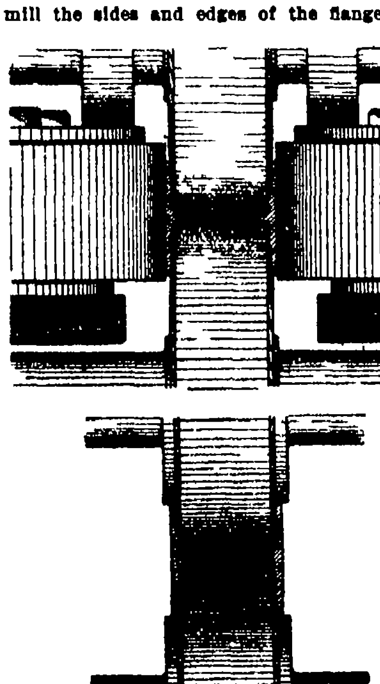


Fig 12 —REVERSING UNIVERSAL MILL

rough and it has consequently to undergo a further operation in the next mill

The second mill—Fig 8—is a non reversing universal mill having non-adjustable horizontal and vertical rolls with their axes all lying in one vertical plane, and intended to reduce the sides of the flanges only. It is proposed to pass the bar through these once, and in order to secure effective co-operation between these and the subsequent rolls and to prevent the formation of fins it is proposed to roll slight depressions in the center of each flange which the next operation will obliterate

The third mill is a non reversing two-high mill having non adjustable horizontal rolls only intended only to reduce the edges of the flanges—Fig 9 It is proposed to pass the bar through them once to bring it to its finished form and to shape the edges whereby the slight depressions formed along the center of the flanges in the previous mill will be exactly filled in this operation and no fins will be left on the finished bar

L D York patent No 410 724 (1889) covers a

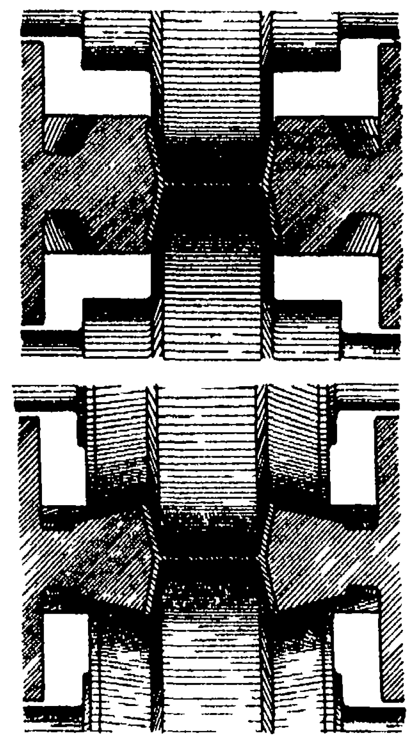


Fig 13 —TWO MILLS ARRANGED SIDE BY SIDE

single reversing universal mill having a pair of horizontal rolls and a pair of vertical rolls with their axes all lying in one vertical plane the horizontal rolls being both alike and symmetrical and the two vertical rolls similarly both alike and symmetrical—Fig 10 It does not transpire how the formation of fins is avoided but some supplemental means would be required as gaps must necessarily occur between the rolls until they have been adjusted to their ultimate positions prior to the final pass and fins would inevitably be formed on the edges of the flanges of the bar

E M Butz patent No 499 651 (1893) describes a series of non reversing universal mills each having a pair of horizontal rolls and a pair of vertical rolls with their axes all lying in one vertical plane the two horizontal rolls being alike and symmetrical and the two vertical rolls being similarly alike and symmetrical—Fig 11 The rolls are non-adjustable having a fixed pass and the bloom is reduced by passing it once only through each set of rolls the pass of which is narrower in each set than in the preceding set until in the last set of rolls the pass has the exact contour of the finished beam Thus as many mills must be used as number of passes necessary to reduce a bloom into a finished beam each mill having its rolls shaped according to the reduction required to be given in each pass

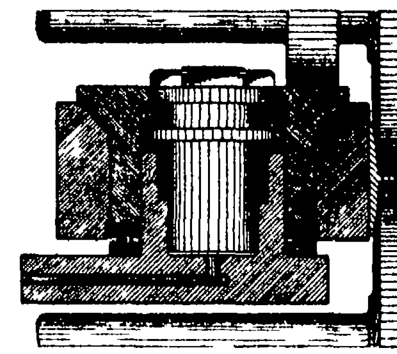


Fig 14 CONTACT BETWEEN ROLLS BY HYDRAULIC PRESSURE

The rolls being fixed and the adjacent surfaces of the horizontal and vertical rolls being suitably shaped so that they are almost in contact with each other it is probable that no very pronounced fins will be formed on the bar but as it is not practicable to close the gaps between the rolls particularly as during rolling considerable deflection takes place and the pass somewhat opens out it is certain that at least beads if not fins would be formed on the corners of the bar flanges Consequently to obviate this Butz proposes to use supplementary means to roll down the corners of the beam flanges adjacent to the gaps between the rolls These consist of two small idle rollers one on each side of the beam as it emerges from the main rolls as shown dotted on the sketch—Fig 11—and so adjusted that at each successive rolling operation the pass between the main rolls would be only just filled up at those corners and there would not be sufficient metal to flow into the gaps and form fins It ap-

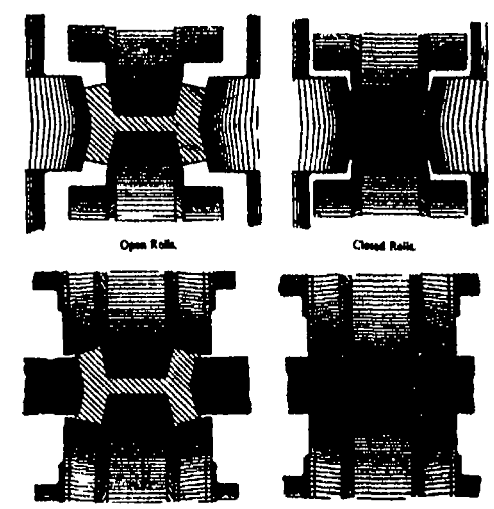


Fig 15 —PRIMARY FOUR ROLL REVERSING UNIVERSAL MILL

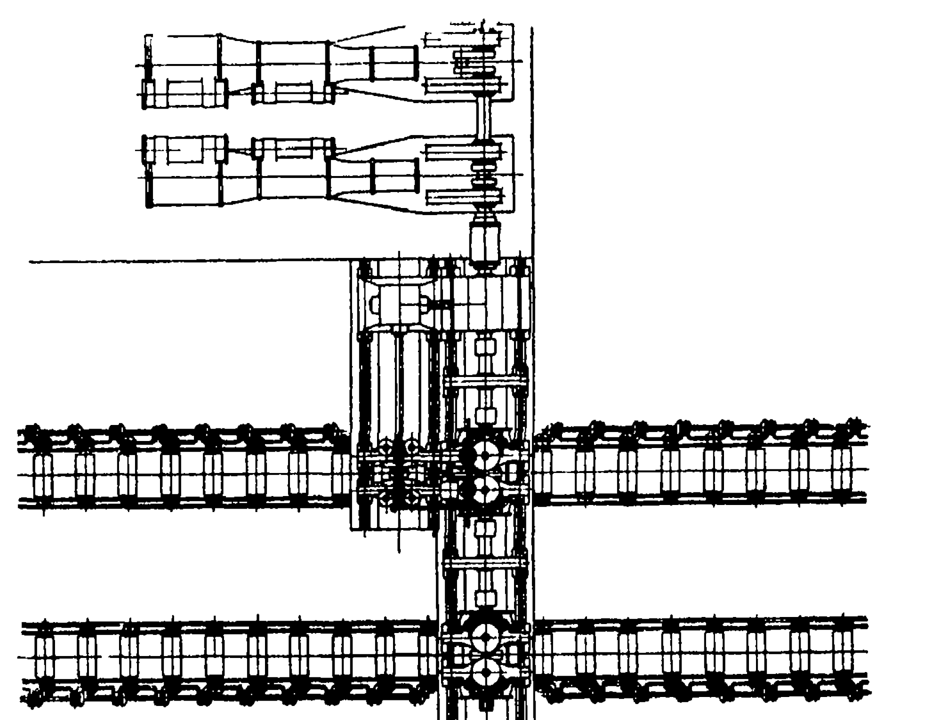


Fig 16 —TANDEM SYSTEM OF ROLLING UNINTERRUPTEDLY BACKWARD AND FORWARD

pears however as if this arrangement would necessitate some means of supporting the flanges as otherwise they would become bent and consequently the corners would not be rolled down in the manner intended

H Grey patent No 587 958 (1897) describes a reversing universal mill having a pair of horizontal rolls and a pair of vertical rolls with their axes all lying in one vertical plane the two horizontal rolls being alike and symmetrical and the two vertical rolls being similarly alike and symmetrical—Fig 12 This mill works in combination with a second mill having a pair of symmetrical horizontal rolls only The first mill has rolls for shaping the web and sides of the flanges of the beam but not the edges of the flanges and the second mill has rolls for shaping the edges of the flanges only

The two mills are situated as close together as possible and have their driving and adjusting mechanisms connected together so that the bar passes through both sets of rolls as nearly simultaneously as possible with such an arrangement Thus on one portion of the bar the flanges are being shaped on their edges while a short distance farther on the sides of the flanges and the web are being formed and the resulting beam is free from fins and presents a good appearance

The foregoing systems of rolling beams devised by different inventors have been chosen as typical and to illustrate the means which experience teaches or ingenuity suggests might be adopted to overcome the chief difficulties which were mentioned at the beginning of this paper each pointing out the direction in which the endeavors of the inventor were brought to bear and each possessing features which although involving complications as compared with the ideally simple plant represented by a pair of horizontal grooved rolls yet to be considered for the time being at least as having their justification in the better quality of the product obtainable thereby or in the ease cheapness or speed of production

The author does not assume of course that the systems he has chosen for his illustrations were all intended by their several inventors as means for manufacturing H or wide-flanged beams as differentiated from I beams or beams of the ordinary standard sections but they illustrate some of the features which the practical designer of to-day is likely to take into consideration in evolving a mill suitable for the production of H or wide flanged beams

For the production of beams with abnormally wide flanges in short H beams it may be assumed that a universal mill having four rolls—two horizontal and two vertical—all lying in one vertical plane is the simplest type of machine that can satisfactorily answer the purpose A single reversing universal mill requiring a tilting gear on each side with which the bar is turned half round after each pass is described by H Sack and also by J S Seaman These mills look simple but evidently have drawbacks due partly to the introduction of the tilting gears which are complications in themselves and are apt to require considerable time for their manipulation particularly when the beam is long and bent and partly also perhaps to the unsymmetrical section developed at each pass which in the rolls described by H Sack would have the tendency to produce a bar bent sideways and in those described by J S Seaman a bar bent vertically so that very powerful guides would be required in the case of the heavier beams to keep the bar sufficiently straight as it emerges from the rolls to enable the tilting gears to operate satisfactorily Briefly in other words the unsymmetrical rolls probably render other complications necessary in order to counteract their bending effect.

A three-high universal mill housed within one pair of stands only and requiring a lifting table on each side is described by J S Seaman—Fig 6—and this would doubtless be a simple system to adopt if it were practicable to design the details of the roll satisfactorily and simply as regards the accommodation and adjustment of the vertical rolls in particular Hitherto the author has not discovered a design of such an arrangement which would be considered satisfactory by him self or by the practical man

Two mills arranged side by side and having rolls such as those of H Sack or by J S Seaman could be adopted and tilting avoided by making the horizontal rolls and the vertical rolls symmetrical in each case but so formed that in one mill the edges of the flanges would be formed by the horizontal rolls only and in the other mill by the vertical rolls only—Fig 13

Then after each pass the bar could be shifted from the one mill to the other being rolled alternately in each mill until completely reduced By this means the formation of fins would be avoided but the plant would be considerably complicated and as the centers of the passes in the rolls of the two mills could not conveniently be arranged very close together the shifting gears would require to be particularly powerful and quick-acting in order not to lose much time over this operation

A plurality of mills having universal rolls or horizontal rolls only each mill intended for developing a certain portion of the section, is described by J Kennedy and H Aiken and also by H Grey but whereas the former leave certain portions of the section to take care of themselves in the initial passes and to be worked upon in the final stages only H Grey works upon the whole section at every pass and his system appears to possess advantages and to combine practicability and simplicity to a greater extent than the other systems hitherto described

Finally a series of universal mills each working upon the whole section of the bar but each adapted for one pass only is described by E M Butz This system would entail perhaps the maximum outlay on plant and machinery and would possibly be adapted for the maximum production per unit of time For rolling rails of which thousands of tons of one section can be disposed of on a single contract, a plant of this description might possibly be a good investment but for the manufacture of beams it seems more than doubtful whether it would be profitable to roll a sufficient quantity of each section to justify the expense of the plant and the time and trouble involved in changing so many sets of rolls for each section of beam

Having dealt at some length with the various means adopted to overcome or prevent the formation of fins which has been shown to be a matter of great importance calculated to influence enormously the design of the rolls of the mill containing such rolls and even of the disposition of the whole plant some mention should be made of the other features of the designs illustrated for which they have also been specially selected

J S Seaman J Kennedy and H Aiken E M Butz and H Grey have all endeavored to devise means for driving all the rolls of their universal mills whereas H Sack and L D York make no attempt to drive the vertical rolls but content themselves with driving both the horizontal rolls and letting the vertical rolls rotate by contact with the moving bar as it is drawn through the pass by the driven horizontal rolls

J S Seaman shows conical surfaces on the horizontal rolls engaging conical surfaces on the vertical rolls contact being maintained between the two rolling surfaces by the pressure of the bar as it is squeezed between the rolls This design has such grave defects that it cannot be regarded as mechanically sound enough for practical purposes for to be effective and avoid excessive wear and tear the sides of the conical surfaces should be at such angles that if prolonged the apices of the cones represented by the prolonged sides would meet at the centers of the respective rolls thus maintaining equal peripheral speed throughout the adjoining surfaces in the same way as bevel gearing is designed This is so obvious that it needs no further illustration but if the vertical rolls were so designed their conical surfaces would make such acute angles that they would have a powerful wedge action and on application of the rolling pressure component forces of excessive magnitude would occur resulting in excessive deflection of the rolls wear and tear and probably a wrecked mill

H Grey shows a device whereby conical or cylindrical collars on the top horizontal roll engage by frictional contact with conical or flat surfaces on the vertical rolls by such means must be so limited as two by means of hydraulic pressure—Fig 14 Like J S Seaman's design this has also the defect that the peripheral speeds of the frictional surfaces are not constant throughout and this defect cannot be remedied without introducing others as great or greater Moreover the driving force imparted to the vertical rolls by such means must be so limited as to render it inoperative for practical purposes Altogether the device looks too unsound mechanically for practical purposes

J Kennedy and H Aiken in their second mill show in contact conical surfaces which are designed on proper lines but between which effective contact could hardly be maintained during rolling for the pressure would cause deflection and spreading of the rolls nor could sufficient pressure be applied in any case to render such contact very effective They suggest however that the friction cones could be replaced by toothed gearing and similar toothed gearing is also suggested by E M Butz but in both cases, although a positive drive would be obtained it would not be possible to adjust the rolls even slightly without interfering with the proper engagement of the gearing

The neatest device for driving all four rolls while still maintaining adequate adjustment between them is that shown in the first mill by J Kennedy and H Aiken In this case the rolling pressure on the horizontal rolls is directly utilized to furnish pressure to give the requisite frictional contact between the driven and the idle horizontal rolls while the vertical rolls are positively driven by gearing Such a device would doubtless give satisfactory practical results but it is doubtful whether the results obtained would compensate for the complications which it involved in the mechanism of the mill.

In the manufacture of 'H' beams a bloom is usually first reduced in a blooming mill to a rough form and thereafter operated upon and finished in the universal mill and the idea that it is necessary to drive the vertical rolls in the universal mill as well as the horizontal rolls appears to be more theoretical than real

The advantage of driving the vertical rolls instead of letting them run idle is most apparent before the bar has been gripped by the rolls as it enters the pass and it is then conceivable that it would be easier to grip the bar if the vertical rolls were driven Once the bar has been gripped by the driven horizontal rolls there is however no apparent drag upon it due to any lagging of the vertical rolls In fact, if a tendency for the vertical rolls to lag behind were present no frictional device on the lines of any of those disclosed would be sufficiently powerful appreciably to diminish such a dragging effect

The best conceivable frictional device for driving the idle vertical rolls is afforded as soon as the bar has been gripped by the rolling surfaces of the horizontal rolls and is in contact with those of the vertical rolls and as before stated an independent frictional drive could only serve a useful purpose providing it were sufficiently powerful by helping to introduce the bar within the pass before it had been gripped by the horizontal rolls but not otherwise

In this connection the fact must not be overlooked that the horizontal rolls do not operate upon the web of the beam alone but operate equally upon the sides and perhaps also upon the edges of the flanges Thus it is not a case of the flanges being pulled through the rolls by a force imparted to the web but as a matter of fact the flanges are directly gripped by the driven horizontal rolls and the vertical rolls are only a form of surface for resisting the side pressure and participate in squeezing the bar and have really no appreciable tendency to slip and lag behind It is obvious however that the horizontal rolls will have a better grip upon the flanges the more the inside faces of these are inclined outwardly and the greater the inclination the greater will be the rolling effect also Consequently the author ventures to express the opinion that the method described by H Sack whereby the section is developed with the flanges outwardly bent from the horizontal center line is not only peculiarly well adapted for rolling H beams having very wide flanges but the material in such beams should also be particularly well worked up and free from internal stresses

The modern tendency is to reduce the inclination of the flanges of beams in order that the material may be better distributed by concentrating it as little as possible in the center of the section and distributing it more outwards in order to obtain a higher moment of inertia and thereby greater strength for a given weight This applies particularly to H beams intended to be used as columns where the least moment of inertia must be used as a basis for calculating their resistance against buckling and where the ideal section should have an equal moment of inertia in all directions

Therefore by so distributing the material in the flanges that a greater amount than formerly is concentrated on the edges of the flanges and a proportionately lesser amount at the roots where they join the web the moment of inertia is increased without increasing the weight of the beam

Now with the system described by H Sack the flanges can just as easily be made parallel throughout, or without any taper as otherwise thus obtaining the advantage of increased strength without adding to the weight of the beam But in addition to this advantage such beams possess the further advantage that they can be drilled and punched rivet and bolt heads bedded and connections with other members made much more easily and cheaply than the ordinary sections having flanges which taper however slightly These advantages are, moreover, obtained without sacrificing in any way the quality of the materials but rather the contrary is the case.

With all systems in which the flanges are developed straight—that is to say with their outside surfaces at right angles to the plane of the web or nearly so—a certain inclination of the inside surfaces is essential to the proper performance of the rolling or reducing operations and the more the taper is reduced the greater will be the risk of damaging the material by reason of the greater tendency of the sides of the horizontal rolls to scrape away instead of rolling or squeezing away the inside surfaces of the flanges; and not only this, but also the greater will be the friction of the horizontal rolls on the inside surfaces of the flanges, and, consequently, the greater the wear and tear on the rolls.

It is obvious that the application of the system described by H. Sack will result in a better beam, a stronger beam, a beam with a better quality of material in it, and diminished wear and tear of rolls, as compared with other systems which do not develop the flanges in an outwardly bent state

The author having been intimately associated with the late Mr. Hugo Sack whom he assisted in the development of his ideas has had the opportunity of making himself thoroughly conversant with the practical aspects of this particular process and he feels convinced that no other system at present known is so well adapted to produce commercially H beams of a good, sound quality as that which the late Mr Hugo Sack invented nearly twenty five years ago and upon which he brought his masterly mind to bear with such persistent energy and enthusiasm

The extensive trials carried on at the Rombach iron works have proved the soundness of the system and they have shown that the direction in which improvements can still be made lies chiefly in the adaptation of the plant for producing large quantities of material on a commercial basis with a minimum outlay in capital expenditure and working cost To this end the author has endeavored to apply the experience he has acquired and ventures to give the results of his efforts in the succeeding

From what has been stated in the foregoing it will be understood that in order to produce H beams free from fins there is a choice of two distinct systems First the mill may be so constructed that one set of universal rolls operates upon the whole of the section excepting where the unavoidable gaps occur between the rolls the positions of which gaps must be changed frequently or at every pass this being attainable with one set of universal rolls forming an unsymmetrical pass as regards the location of the gaps or with two sets of universal rolls each forming a symmetrical pass but each different as regards the location of the gaps—that is to say using a single reversing universal mill and tilting the bar half round between the passes or using two universal mills—which may be reversing or non reversing—and shifting the bar from one to the other between the passes Secondly the mill may be so constructed that one set of universal rolls operates upon the greater portion of the section and is adapted to reduce and elongate the bar as a whole while a second set of rolls operates only upon those portions of the bar which are not operated upon in the first set and are adapted to reduce the bar locally but not to elongate it or reduce it as a whole—that is to say using a primary reversing universal mill in tandem with a secondary reversing mill the two situated so close together that the bar is operated upon by both at the same time although on portions a short distance apart

It is with the second of these systems that the author wishes to deal, because the first is already sufficiently well known and because he believes that the second possesses greater possibilities of development in the direction of economy

H Grey uses a primary reversing universal mill with four rolls operating upon the web and the sides of the flanges of the bar reducing and elongating the bar as a whole but leaving the edges of the flanges untouched and in tandem therewith a second reversing mill having two rolls which guide the bar and operate upon the edges of the flanges only Thus in the tandem mill at every pass the bar is operated upon all over and the formation of fins is prevented

Retaining the system of H Sack in which the beam is developed with outwardly bent flanges the author suggests the employment of a primary reversing universal mill having its four rolls shaped to operate upon the web and sides and edges of the flanges with the gaps between them located somewhat short of the extreme edges of the flanges and sufficiently wide to prevent the extruded metal from cooling too quickly and in tandem therewith a secondary reversing universal mill with rolls shaped to guide the bar and roll down the surplus metal extruded between the gaps of the primary rolls—Fig 15

Any irregularities which might still be left at the edges of the flanges after the last pass in this mill could then be eliminated altogether by properly shaping the rolls so that the final pass required to straighten out the flanges in the separate set of rolls would roll down or fill up any irregularities as the case might be and give the system a final finish all over The tandem system of rolling has the advantage that the beam is reduced all over and extrusions of metal beyond the limits of the desired contour rolled down all in one pass so that the mill may work uninterruptedly backward and forward and no time is lost in tilting or shifting from one stand to another The cost of the equipment should be very slightly if anything more than that of a single mill with a suitable tilting gear; but even if the cost were considerably greater it would be more than justified by the increased output and by the saving of the extra wages which would be incurred in the more elaborate manipulation The plan of such a mill is shown in Fig 16

Where two stands are used and the bar shifted from one to the other an increased output might be looked for proportionate to the increase in the cost of the plant and wages provided that two bars could be rolled simultaneously and non reversing engines used but it is just a question whether the quantity of a given section required to be rolled at one time would justify the additional capital outlay in the plant required for such an arrangement having regard to the fact that the rolls in both stands could be adapted for only one size of beam at a time

Various Finishes for Zinc

Some Interesting Technological Suggestions

Of all the metals entrusted to the electro plater for metalic coating or coloring not one is so easy to handle as zinc whether it is to be nickel brass copper silver or gold plated or whether it is to be colored brown gray violet blue green yellow or purple Not only is the electroplating of zinc easier but it is much the quickest accomplished It is a fact however that one's whole attention is required for the work

In nickel plating zinc particular care must be taken to remove all grease If lime is employed for removing the grease it must be washed off as quickly as possible because the zinc articles are very readily attacked by the lime The best method of removing grease from zinc (Zn) is by boiling it in caustic soda (Na OH) keeping it constantly in motion however It is then brushed off in a watery decoction of Panama bark rinsed in cold water (H_2O) and transferred to the rapid nickeling bath More advantageous however is an ordinary citrate bath because with its use with a current of three to four volts the object can be heavily nickeled in five minutes without moving it about

In brass-plating zinc special care must be taken to scratch it well after a few minutes and not with a steel but with a circular brass wire brush The opinion of many tradesmen that the scratching of brass or copper is purposeless is entirely wrong. The more an object is scratched the heavier a deposit can be had The brass bath for zinc consists of

- 1 500 parts pure potash H_2CO_3
- 60 parts chloride of copper $CuCl_2$
- 105 parts chloride of zinc $ZnCl_2$
- 640 parts nitrate of ammonia NH_4
- 30 parts cyanide of potassium CN
- 10,000 parts distilled water H_2O

This bath is used at a temperature of 77 to 86 deg F and with a current of three volts

In copper-plating zinc, the same process is resorted to as in brass-plating, but the copper bath can be so made up that the scratching of the object may be omitted. It is composed as follows

- 15 parts neutral acetate of copper CuO
- 12 parts spirits of salammoniac, NH_3 (Spec grav 0.96)
- 35 parts crystallized soda, Na_2CO_3
- 15 parts pure sulphite of soda, Na_2SO_3
- 16 parts cyanide of potassium (99 per cent) CN
- 10,000 parts distilled water, H_2O.

If the articles to be copper-plated are of cast zinc it is better to use a copper bath with which scratching is [illegible]. Such a bath is made up as follows: [illegible] parts blue vitriol $CuSO_4$

- 1 500 parts seignette salt (potassio sodi tartrate) $C_4H_4O_6$
- 800 parts caustic soda NaOH
- 100 parts spirits of salammoniac NH_3
- 10 000 parts distilled water H_2O

If cast zinc articles are scratched any non-conducting casting residues that may be present will be eliminated and a much finer coating is obtained than without scratching

When silver plating zinc special attention must be bestowed on thorough amalgamation Every spot where the zinc has no coating of quick silver will after the scratching turn black in silver plating and the entire work will be useless The amalgamation or quickening bath is made up as follows

- 150 parts of cyanide of mercury Hg $(CN)_2$
- 150 parts cyanide of potassium CN (99 per cent)
- 10 000 parts distilled water H_2O

Having assured ourselves that the object is well cleaned it is then drawn quickly through the mercurial solution and rinsed off in clean water After having been passed through once more they are ready for the silver bath If the perfect removal of grease is doubtful then the quickening bath must be diluted with one third the volume of distilled water so that the zinc objects can be allowed to remain longer in the solution Care is however necessary for even the heaviest plates will crack in the quickening bath In silver-plating a very strong current is turned on at once but it is allowed to act for but a short time (one to one and a half minute) and the tension is reduced to one to two volts After five minutes the goods are transferred at once to the scratching bench and after washing another quickening is advisable The density of the silver bath should be about 10 to 15 deg Baumé.

The gilding of zinc calls for no very great experience A slight cleaning (pickling) suffices and the gold bath can be used as for other metals the gold being dissolved in boiling hydrochloric acid When the gold is all dissolved the chloride of gold ($AuCl_3$) is added to H_2O cyanide of potassium being at the same time added.

Zinc can also be readily colored without the employment of current, red for instance in the following composition

- 50 parts blue vitriol of copper $CuSO_4$
- 25 parts bi-carbonate of soda, Na_2CO_3
- 10 parts tartar, $C_4H_5O_6K$
- 10 parts sulphuric acid, H_2SO_4
- 1 000 parts distilled water, H_2O

The articles are immersed for a short time in the bath, which soon deposits a fairly heavy copper coating. Zinc as a component of brass, cannot be brass plated without current but is very easily gilded For silver plating it is likewise necessary to use the electric current

The patina on zinc is produced as follows

- 100 parts hypo sulphite of soda $HNaSO_4$
- 1 000 parts distilled water H_2O at 100 deg C
- 50 parts English sulphuric acid H_2SO_4 (stirring constantly)

In the decanted solution of about 60 deg to 70 deg C (140 deg to 158 deg F) of sulphite of soda Na_2SO_3 and sulphurous acid H_2SO_3 pickled pieces of sheet zinc are laid After one to three minutes they acquire a pale green very brilliant coating By frequent treatment the deposit is changed to the deepest gray color

Iridescent colors are obtained in the following solution

- 10 parts dry tartrate of copper Cu_2OH_2O
- 2 parts caustic soda NaOH
- 150 parts distilled water H_2O

According to the duration of the stay in this bath, we attain from a violet color to a very dark red

If a marbleized finish is desired pour on the sheet zinc while the coloring is still wet in some places hydrochloric acid and immediately after rinsing a five per cent solution of sulphate of copper in H O

To a previously mentioned solution of sulphurous acid add

- 15 parts chrome alum $Cr_2 3SO_4 + K_2SO_4 + 24H_2O$
- 1[?] parts hyposulphite of soda HNaSO

whereby a more brownish color is imparted to the plates

A bronze finish can also be produced on cast zinc but in this case a previous brass plating is necessary After this the dried objects are painted with a solution of

- 100 parts gold sulphur SbS_3
- 50 parts salammoniac, NH_3
- 10 parts hyposulphite of soda $HNaSO_4$
- 50 parts acetate of alumina Al_2O_3

Dried in a warm stove then again coated and after dying brushed with a soft brush By dipping in a ten per cent solution of cyanide of potassium (CN in H_2O) the coating becomes black.

To color the zinc directly black the arsenic bath composed as follows is used

- 1 000 parts arsenic, As.
- 100 parts cyanide of potassium CN 99 per cent
- 40 000 parts distilled water, H_2O

The articles change from green to blue, red brown, violet and slowly turn a deep black —Translated from *Die Edelmetall-Industrie* for the SCIENTIFIC AMERICAN SUPPLEMENT

A Remarkable American Forest Railway

The Profitable Industrial Road in Michoacan, Mexico

By A. Reiche

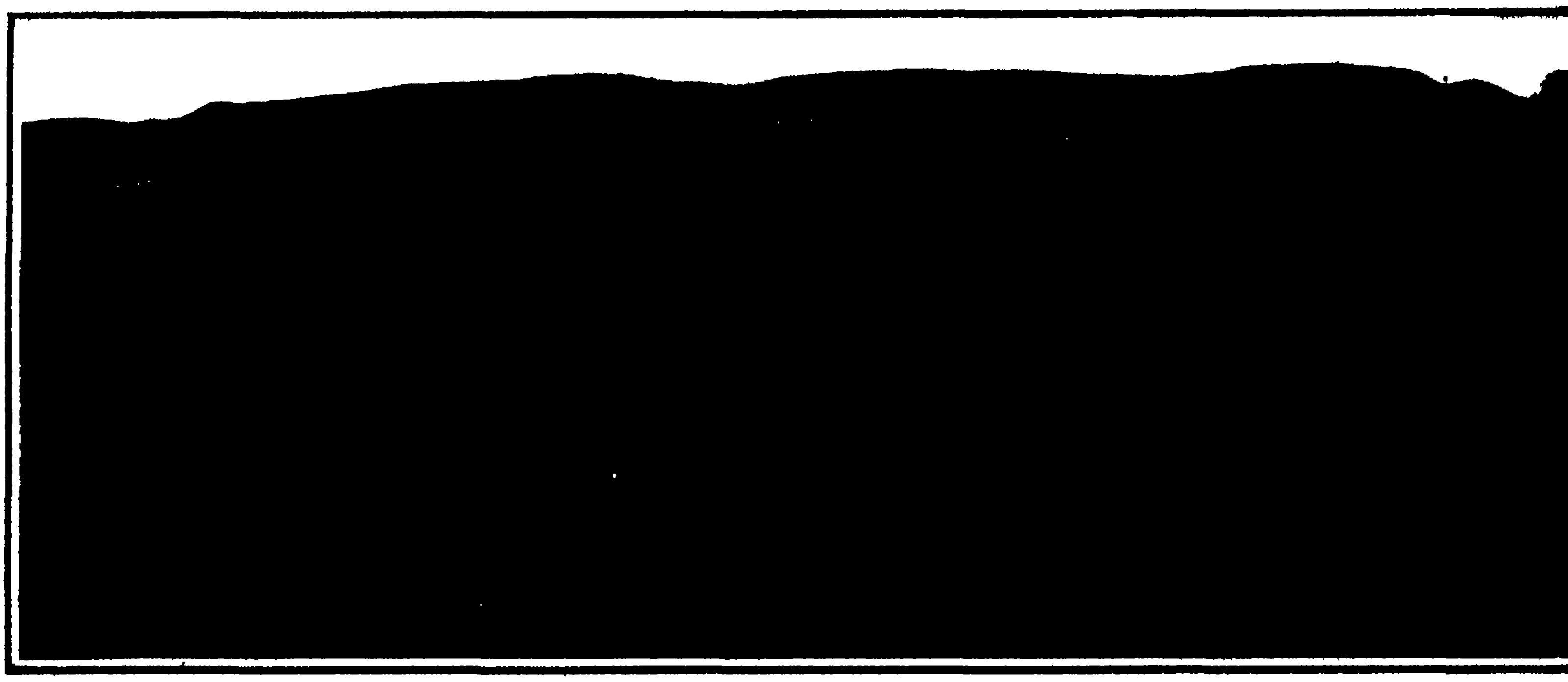
When the twin ribbons of steel blazed the way through the wild western lands the United States began to grow with rapidity. The railroads opened untold possibilities and then developed them. The same thing in a smaller degree is and has been true in other countries, notably Mexico.

It is said by enlightened visitors to the republic presided over by President Porfirio Diaz that Mexico has been standing still because the majority of its inhabitants are ignorant. It has been the American on the line of the Mexican National Railway to the hacienda San Joaquin Jaripeo. The province of Michoacan lies half way between Mexico City and the Pacific Ocean and is in the foothills of the southern range of the Sierra Nayarit Mountains.

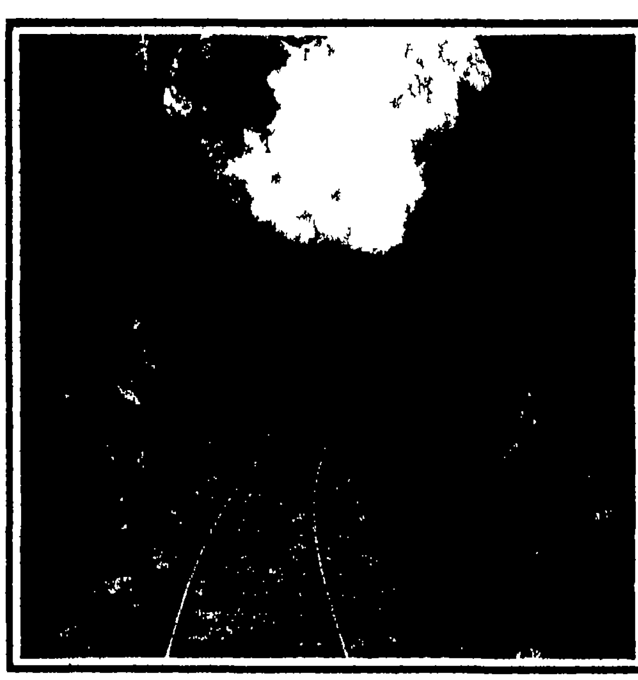
The hills and mountains in this part of Mexico are covered with a dense forest of oak and pine which grow to a height and size not often reached in the United States, as may be seen in the accompanying engravings.

scale. The distance from Huingo to the [illegible] 24 kilometers (14.9 miles) and it was decided to build their mills at the hacienda, making the line from there to Huingo the main line, and [illegible] fairly heavy construction, while from the hacienda out through the forests branch or feeder lines were to be laid which would be of lighter construction, of narrow gage and therefore could be easily shifted and moved as desired.

After consultation with a well known Pittsburg com-



A VIEW IN THE LOWER FOOTHILLS OF THE SIERRA NAYARIT SHOWING THE GREAT NATURAL GEOGRAPHIC OBSTACLES WHICH HAD TO BE OVERCOME



CUT THROUGH A HILL

TYPES OF THE ROLLING STOCK

A REMARKABLE AMERICAN FOREST RAILWAY

who has carried a spirit of enterprise into the country and rel[illegible] the backward and unprogressive land [illegible] to a progressive one which is now rapidly forging ahead.

Railroads have done their big share in Mexico's transformation and no small part must be given to [illegible] the narrow gage lines which [illegible] the density of the forest and unlock the doors of untold wealth that for years have been hidden because of [illegible] means of transportation. Over plains, through valleys and ravines, over mountains and through forests, the industrial railway has been [illegible] establishing a means of easy communication between vast and wealthy plantations and the marts of trade [illegible] the centers of densely inhabited Mexico along her seaboard.

One of the most profitable industrial railways through a Mexican forest is in service in the province of Michoacan and extends from Huingo, a station

On account of the rapid development of railways and mines in Mexico and the coal deposits not having been developed to any considerable extent, there is a large demand for lumber, railroad ties and wood for locomotive and furnace fuel uses. This demand is greatest in northern Mexico, and as the forests in Michoacan afford the nearest and best supply, it can be seen why great inducements were offered to the land owners to develop their timber property. This the owners of the hacienda San Joaquin Jaripeo, one of the largest estates in Mexico, did to some extent for several years, but as they were compelled to convey the timbers to the nearest railroad station, Huingo, by mule and by ox teams, very little progress was made, as they were not in a position to take large contracts and the cost of haulage grew prohibitive as soon as the distance became larger.

They finally determined to construct a railroad for their own use and to develop their land on a large

pany it was decided to construct the main line of a 48-inch gage or 1219.2 millimeters, while the branch lines were to be a 24-inch gage or 609.6 millimeters.

They accordingly placed an order with the above-named company for the complete equipment, consisting of rails, switches, locomotives and lumber cars.

From the survey it was found that the country sloped downward from the hacienda steeply for the whole distance, and that instead of having to plan the line to avoid grades against the loaded trains, it would be a question of making the grade small enough to permit locomotives of the ordinary type operating on it and at the same time have tractive power sufficient to haul back the empty cars. A line was finally laid out which averaged about five per cent down grade. This was accomplished partly by avoiding as much as possible all points which would cause heavy excavation or high fills and blasting of rock. While this policy made the line [illegible]

SKIRTING A HILLSIDE WHERE THE SKILL OF THE ENGINEER IS TAXED

ONE OF THE MANY STREAMS WHICH HAD TO BE CROSSED AND RECROSSED

SOME OF THE TIMBER

TRESTLE OVER A DEEP GORGE

A REMARKABLE AMERICAN FOREST RAILWAY

more degrees of curvature than would be regarded as standard practice in railroad construction yet it avoided the necessity of using an extensive plant for construction work, and what was more essential, the need of skilled laborers.

The only labor obtainable in the surrounding country were the peons who lived on the hacienda and as bids obtained for the construction work were enormously high on account of the remoteness of the place and the comparatively small job the owners decided to do the work themselves by using only their own plantation laborers This of course added to the length of the time the line was under construction, as the force at work varied at different seasons of the year according to the other demands on the laborers but resulted in a very cheap construction account, in spite of the fact that it was not possible to avoid some very deep cuts and the construction of numerous bridges and trestles as can be seen pictured in the illustrations.

The excavation work was done entirely with hand labor by pick and shovel with the aid of an equipment of the well known V-shaped double-side dump cars of one cubic yard capacity and of portable track which are built by the Koppel company This outfit was ideal for the purpose as the units were all light enough to be easily handled by a few men on any ground The cars of course were hauled by mules or oxen.

The abundance of fine timber supplied the material for the bridges and trestles, and trestling was done wherever possible, as it required less skilled work than bridge construction called for, and the units to be handled were smaller

Handling of rock was avoided as much as possible, as stated, and one of the illustrations shows a detour made to escape some boulders.

As soon as the main line was completed which took about two years the narrow gage lines radiating out from the hacienda were started and are being extended gradually as required

The equipment of the lines consists of platform cars (for which the iron parts were purchased the super structure being built by the owners) locomotives of 40 and 50 horse-power for the main line and lighter ones of 20 horse power for the 24 inch gage lines There are also some passenger cars and a private car for the use of the owners and their guests

It can readily be seen that the only work done by the locomotive on the downward trips is in controlling the speed of the train by its braking power

A party from the ranch often takes the private car and runs down to Huingo governing the car by brakes

With regard to the cost of the line no exact con struction expenses were kept but the total expenditure on the lines so far constructed including equipment has been from $600 000 to $700 000 Mexican or $300 000 to $350 000 gold

As soon as the main line was finished the project was placed on a paying basis almost at once as the owners were able to take large contracts for railway ties and fuel from the Mexican National at excellent prices

Although the extent of this road is not so very great and no great engineering works were involved in its construction yet it is interesting from the fact that it was built and brought to a satisfactory conclusion by unskilled labor and by supervision through wild and mountainous country It also shows the value of such narrow gage or industrial railways for cheaply developing the resources of a country which otherwise would be inaccessible for the use of mankind

To coat iron with a covering of lead which will be in absolute metallic contact states the Chemical Trades Journal is a difficult operation Valves and small fittings made of ir n well galvanized on the exterior may be hom geneously c vered with lead in the workshop by any mechanic The method consists in immersing the piece to be coated in water to which a few drops of sulpl uric acid have been added Then while in the acid water the piece is readily amal gamated in the usual way by squeezing mercury through close-woven cloth all over its surface and thoroughly rubbing it in The excess mercury is rubbed off and the piece carefully dried without heat, and then immersed in a bath of lead which should be well above its melting point so that it would not tend to solidify by introduction of the cold piece The casting may be withdrawn after about 20 seconds and will be found to be homogeneously covered with lead This i ethod requires the piece to be galvanized before applying the lead and the galvanizing must be in good condition otherwise the subsequent amalga mation will be imperfect On account of the mercury fumes given off it is not an operation one would wish to carry out day in and day out and on large pieces but the method is simple and of cours can be applied to any metal or alloy that can be amal gamated

Science and Engineering*

Sir J J Thomson's Comments on a Vital Subject

CONSPICUOUS among the qualities which have raised Sir J J Thomson to a foremost position among living physicists has been the success with which he has been able to imagine working models of the complicated electrical processes which he has investigated with so much originality and power He appears indeed to regard physical phenomena from the standpoint of the engineer and not from that of the philosophic mathematician whose equations are but pale reflections or images of substantial particles of matter in motion but merely a collection of recipes for acting or reacting on Nature This latter mental attitude at one time greatly favored in certain parts of the continent is no doubt logically inexpungable but it may be safely asserted to have been almost barren of results being conducive neither to the establishment of new facts nor to the origination of fertile speculations It is what may perhaps be termed Sir Joseph's Faradian methods of exposition which have rendered his annual course of lectures at the Royal Institution so peculiarly fascinating to those who while desirous of learning something as to the present drift of the unceasing advance in matters scientific have neither time nor opportunity to make a serious study of mathematical physics

In his presidential address to the Junior Institution of Engineers dealing with The Relation of Pure Science to Engineering Sir Joseph attributed his tendency to regard physical phenomena as reducible to aggregates of matter in motion to the fact that like the late Henry Rowland of Baltimore he commenced life with the intention of becoming an engineer and in his case studied to this end under Prof Osborne Reynolds one of the ablest and most original thinkers that has ever filled a professorial chair in engineering Circumstances led Sir Joseph subsequently to choose a fresh path in life and science has gained what engineering has lost It would seem however that he has never seen reasons to regret his earlier training for a profession in which it is all important to study actual phenomena and not merely the mathematical forms by which their interrelations can be more or less successfully expressed

In his address he claimed that the methods of the physicist and of the pioneer working in the engineering field are largely akin and indeed Mr Swinburne has expressed much the same view in one of his own presidential addresses The difference between the two lies mainly in the aim The physicist is in the fortunate position of being able to seek out the facts of Nature with no ulterior motive while the engineer's groupings in the well of truth are in the main to be quite frank a hunt for dividends The justification for his work must be found in the fact that in one way or another it must pay Where this necessity is removed as in government service stagnation seems inevitably to result A leading American authority has remarked that up to the taking over of the telegraphs by the government some thirty years ago the improvements made were almost wholly of British origin but since then they have been almost exclusively exotics although in able telegraphy, which remains in private hands we still retain our supremacy as fertile and original workers Similarly the many thousand miles of state railways in operation abroad have contributed practically nothing to the solution of problems in transportation

The luckier physicist who finds his sphere in the laboratory or in the study needs no commercial justification Shallow thinkers will doubtless hold that the aim of the physicist must accordingly from the standpoint of the moralist be ranked higher than that of the engineer but any attempt to institute an effective divorce between idealism and materialism is as futile as that to solve the famous problem as to the relative priority of the bird and the egg The existence of the one presupposes that of the other and while the world rightly honors those engaged in the pursuit of science for its own sake such a pursuit is rendered possible solely by the fact that the engineer and the business man are attending to the more immediate and pressing necessities of mankind He who invests in consols or municipal securities escapes indeed the thoughtless taunt of being a mere greedy hunter of dividends but is in truth a less useful member of society than if in the hope of a larger return he had aided in the development of say the telephone the steam turbine or the aeroplane

As was perhaps to be expected Sir Joseph proved himself a strong advocate of the works laboratory and research department and he remarked that the balance sheets of those firms whose laboratories were the most extensive did not suggest that they were ruining themselves in the cause of science It would seem, however that in many cases the laboratory is as much the result as the cause of large dividends It is, indeed impossible for a firm which returns its ordinary shareholders a mere 5 or 6 per cent in a good year and nothing at all in a bad one to embark on a large expenditure on pioneering work which is necessarily of a highly speculative character Such gambling risks can only be run by more prosperous undertakings and the struggling firm has perforce to content itself with business of a more humdrum character Fortunately we still have some highly prosperous engineering firms who are in a position to make ventures in experimental work to the extent of many tens of thousands per annum In mechanical engineering however the laboratory will always play a somewhat secondary part its utility being much less marked than it is in the case of chemical and metal lurgical establishments The Parsons steam turbine for example was raised from little more than a toy to its present pre-eminence with appliances in the way of laboratory equipment which would excite the derision of a Continental engineer One foreign firm noted for the lavishness of its expenditure on laboratory research is said to have expended nearly half a million sterling on the unsuccessful attempt to excel the Parsons machine calling to its assistance university professors demonstrators and graduates in engineering who were most liberally financed However in real pioneering the engineering laboratory probably counts for little Ability of the first order is not purchasable at will in the open market and the works laboratory is commonly staffed with less original men who are however often extremely useful in developing ideas from outside

Sir Joseph in his address raised a timely protest against the not uncommon but short-sighted contention that it is a wise plan to let other nations spend their money in developing new processes and to wait until the preliminary difficulties are overcome and success assured before taking them up Against such a policy there are many arguments Even as a matter of pure finance the practice is unsound The profits of successful pioneering are extremely large In the early day of the heavy electrical industry in this country dynamos costing some £30 to build readily sold for over £90 and the profits thus secured sufficed to build up an establishment which starting with a total of some four of five hands had become in three or four years the largest in the world engaged in that class of work and employed hundreds of work men Its prosperity was then checked and all possibility of further pioneering in the heavy electrical trades destroyed so far as this country was concerned by Mr Joseph Chamberlain's disastrous Act of 1882 The fallen scepter passed to America and to Germany where the enormous establishments of the A E G not only pay regularly a high dividend to their fortunate shareholders but the works themselves with all their elaborate plant and equipment stand on the books at but a nominal figure having been written off out of profits

The monetary returns attendant on successful pioneering constitute however only one of its advantages The process opens a career to men whose *forte* lies in their originality rather than in their organising ability or painstaking industry Moreover almost every firm that has tried it will we think admit that it is not possible to purchase experience over the counter along with working drawings Many for example have taken up the manufacture of large gas engines to Continental designs paying heavily for the privilege in the fond belief that they would thus at once be able to put the construction of such engines on a manufacturing basis In many cases however the transaction has resulted in serious loss and disappointment and it has been necessary to spend large sums in acquiring by trial and experiment that experience which they vainly imagined they had secured by the simple process of purchase

To no small degree this history is repeating itself in the case of Continental designs for steam turbines An instance could be quoted of two firms engaged in a very similar class of work both of whom decided to take up the manufacture of small steam turbines. The one purchased a Continental design, costly to build and but moderately efficient, and have not yet attained to commercial success in spite of much work The other firm entering the field later determined to build their own turbine *ab initio* and succeeded The very first built ran without a hitch from the start gave most excellent results in the matter of steam economy and actually cost less to construct than was paid in cash down for its Continental rival, which is, moreover, still subject to a royalty per horse-power turned out. It may be added that the firm bold enough to construct its own machine realised from the outset that the supposed necessity for employing technical students from Continental schools for such work is wholly imaginary and is likely, owing to their imperfect knowledge of the practical side of engineering, to lead to serious losses of time, money, and material. The thermodynamic aspect of the steam turbine is, indeed much less important than the mechanical, and a sufficient knowledge of the theory is not difficult to acquire

In concluding his address Sir Joseph insisted on the importance of a knowledge of mathematics to the engineer and it is a view with which we have much sympathy although it must be confessed that in mechanical and constructional engineering, as opposed to electrical opportunities for the useful employment of higher mathematics are few and far between Still the training is valuable although experience has shown that certain types of men are inclined to use mathematical formulæ as a substitute for serious thought The late Sir Benjamin Baker had he had time for it, could probably have derived profit from even a minute study of the mathematical theory of elasticity Smaller men however, find it difficult to resist the temptation to design structures so as to simplify them mathematically sacrificing to this end much more important considerations Indeed this tendency seems to have been at least partially responsible for the Quebec Bridge disaster as it was also for the collapse not long ago of a very large shipbuilding crane supplied by a leading Continental firm A well known American engineer again has declared the use of plate girders to be most unscientific since it is impossible to calculate with reasonable accuracy the stresses to which they are subjected Riveted trusses meet the same condemnation although experience with them as with plate girders has been most satisfactory

At Winnipeg last year Sir Joseph drew attention to the great difficulties attendant on the application of mathematics to physics and we believe that the difficulties are even greater in the case of mechanical engineering The partial differential equations which arise in the mathematical theory of elasticity are, in fact very much more complex than those of Laplace which we presume may be taken as the basis of mathematical physics It is morever even in solvable cases extremely difficult and indeed, often impossible to make the boundary conditions," necessarily assumed agree with actual practice To this may be added the fact that no adequate theory as to strength of statically indeterminate structures exists though the stresses can often be calculated with practical accuracy Thus in New South Wales there are now standing apparently satisfactorily a number of reservoir dams in which the stresses calculated by the mathematical theory of elasticity exceed the breaking strength of the material and we question whether an engineer well versed in this theory would have ventured to erect them They are, nevertheless highly economical of materal and prolonged experience of a somewhat similar type in the United States gives reason for believing that they are safe

In fact in all but the simplest class of structure or machine part the mechanical engineer has to rely upon physical rather than on strictly mathematical considerations He forms an image in his own mind as to the general character of the stress distribution and of the various ways in which failure may occur and provides for these by somewhat rough and-ready methods In the case of the Assouan Dam for instance while his Continental colleague was much concerned as to the necessity of keeping calculated stresses below a certain limit, the late Sir Benjamin Baker attributed less importance to such considerations, since the severest stresses to which the structure would be subjected would, he knew, arise from incalculable changes of temperature He paid special attention, accordingly to the stability rather than to the strength of the structure.

The foregoing comments are not intended to belittle the importance of mathematical knowledge, but merely to draw attention to the extreme difficulty of applying mathematical theories in one particular, but very important branch of engineering, and to draw attention to a certain danger, which experience has shown to exist, that a skilled mathematician may design a structure to suit his methods of computation rather than to carry its load in the most effective way. The mechanical engineer has, in practice, often to employ methods of reasoning akin to those of Faraday; and it is, perhaps, doubtful whether it will ever be possible for a Clerk Maxwell to throw them into strict mathematical form.

* *Engineering*

Trans-oceanic Aviation

An Analysis of Brucker's Project

THE recent long distance flights demonstrating the improvements that have been effected in the construction of aeroplanes both theoretically and mechanically, have revived says Engineering the interest in some ambitious schemes proposed to test the capacity and the outlook of aerial locomotion. Foremost among these is the plan to cross the Atlantic in an airship. Such a project had its origin in the fertile brain of an American journalist Mr. Joseph Brucker and his enthusiasm has so far affected others that a committee has been formed which on both technical and financial grounds is capable of starting this project on the road to fulfilment. The scheme has advanced to the point of placing contracts with German firms of recognized standing who are prepared to provide the necessary equipment which will include in addition to a dirigible balloon of large dimensions, a stout seaworthy boat to be attached to the airship and to be used in case of accident to the aerial apparatus. The plan involves therefore not only the carriage of a certain number of passengers across the Atlantic but also of a vessel in which the journey might have been made. While we commend the caution thus exhibited it is evident that trans oceanic flight handicapped in this manner will make little progress.

The balloon itself is necessarily a serious affair but far less capacious than a Zeppelin. It will be of elliptic form about 160 feet long and nearly 50 feet in diameter in the center. To obviate the difficulties arising from solar radiation the gas bag will be inclosed in an outer covering of some non heat-conducting material leaving an air space of 4 inches or 6 inches between this covering and the gas bag proper. At the same time a ballonet of peculiar construction which is still a matter for experiment will be provided. In this way it is assumed that the loss of gas will be reduced to a minimum and no untoward circumstances arise from the inevitable heating of the balloon covering. Immediately under the balloon there is to be a platform capable of accommodating a crew who will have to attend to the steering balancing gas control etc. and below this again in the place the car usually occupies will be a substantial boat 30 feet long and about 9 feet beam. In the hold of this boat will be carried a motor of some 40 horse-power capable of revolving the air propeller or if adverse circumstances supervene the screw of the boat when lowered into the water. This boat also carries a large tank of gasoline provisions kitchen galley etc.

Numerous ingenious devices have been introduced and that the scheme is practicable for a certain distance may possibly be admitted. But the step from covering a few hundred miles on land to one of some thousands over sea is a formidable one. It may not be too much to say that the risks increase with the square of the distance traversed. One would like to have more assurance on the question of navigation or the accurate determination of position. Ocean currents of a slow moving and well recognized type and of whose position the navigator is perfectly aware can work very disastrously on ships and it seems not impossible but that in the swifter and unknown aerial currents there may lurk a source of danger which has been very inadequately apprehended. One can imagine circumstances in which the compass would become useless and sextant observations more uncertain than on the unstable deck of a ship. But the dangers threatened from these sources are so obvious that we may be sure they have been considered and provided for by the members of the committee of which we have spoken.

The proper course for the airship to follow has been a matter of grave consideration. The principle that determines the laying of a submarine cable does not apply here. The shortest course naturally confined to high latitudes is not the most suitable. The one factor to be considered is the prevailing direction of the wind and this when known will decide both the most judicious course and the season of the year for the attempt. The air-current known as the trade wind which carried the frail bark of Columbus to a safe haven in the West Indian Isles will be selected to carry the first airship above the waves of the Atlantic Ocean. The trade winds secure a tolerably uniform current of air in a zone varying little from 20 deg north latitude. In the winter and spring months a velocity of from 14 to 16 miles an hour can be confidently anticipated and these are also the months that are most free from disturbing cyclones. Therefore the attempt will be made in the spring and the direction of the current from east to west decides that the aeronauts shall start from Europe and endeavor to reach America. Not only will the force and direction of this current prove of great assistance but in the zone in which it obtains there is small variation in the daily temperature. Since it is desirable to keep the gas at a constant temperature this fact is also in favor of the route etc. of the scheme. The greatest chance of success therefore points to a course which starting from Cadiz will pass by Madeira and Teneriffe and maintaining a generally W. S. W. direction will endeavor to make Porto Rico. Thence along the chain of islands leading to Havana this course is easy. On leaving Cuba New Orleans will be the goal and finally across the States to New York. The whole passage involves a journey of more than 7 000 miles divided as follows:

	Miles
Cadiz to Teneriffe	807
Teneriffe to Porto Rico	3 219
Porto Rico to Havana	1 124
Havana to New Orleans	674
New Orleans to New York	1 382

It is estimated that the journey across the ocean can be completed in five or six days but the airship will be provided with gasoline and equipment for a much longer period.

Supposing the experiment is carried to a successful issue it will be asked What does it prove? What new scientific fact has been gained? What prospects does it open up for improved locomotion or more economical modes of transit? We must confess that however dazzlingly the project may appeal to the imagination however convincingly it displays the power of science and ingenuity it will remain we believe a barren result. The promoters must naturally take a more hopeful view. It is for them to put forward some tempting by-products as an inducement or as an excuse for the expenditure and the risk. They urge that meteorology will be provided with more exact knowledge of the behavior of the trade winds and of the motion of the upper atmosphere while aeronautical problems will be studied on a scale which will remove the hindrances by which advance is now beset and introduce processes that will revolutionize the ordinary methods of travel. Advocates of aviation foresee the construction of airships that will have a velocity which combined with that of the trade wind will transport the hardy aeronaut to America in the short space of fifty hours. We find it difficult to share these roseate views at least as the result of a single experiment. What form aerial craft may be destined to assume in the future cannot be predicted but as far as can be seen at present high velocities are limited to the heavier-than-air machines. By constantly increasing the velocity the area of the supporting surface may be as continuously reduced and this rule may point to the adoption of a form of helicopter as the racing machine of the future. The possibilities of the dirigible balloon seem limited to being the burden-bearing machine of the future capable of carrying considerable tonnage at a low speed. In this capacity a very useful career lies before it.

Fog Scales

IN the United States observers of the Weather Bureau designate as a dense fog one that obscures objects at a distance of 1 000 feet. If objects are not obscured at that distance the fog is described as light.

Is it desirable and feasible to describe the gradations of fog more minutely? English meteorologists have answered this question in the affirmative. The London Fog Inquiry of 1901 1902 conducted by the British Meteorological Office gave precision to many of the ideas of meteorologists concerning fog and one of the results of that inquiry was the adoption by the Meteorological Office and the Admiralty of a fog scale of five steps as follows:

	On Land	On Sea	On River
Slight fog or mist.	1 Objects indistinct but traffic by rail or road unimpeded	Horizon invisible but lights and landmarks visible at working distance	Objects indistinct but navigation unimpeded
Moderate fog	2 Traffic by rail requires additional caution 3 Traffic by rail or road impeded	Lights passing vessels and landmarks generally indistinct under a mile. Fog signals are sounded	Navigation impeded additional caution required
Thick fog	4 Traffic by rail or road impeded 5 Traffic by rail or road totally disorganized	Ships lights and vessels in visible at ¼ mile or less	Navigation suspended

For the determination of fog densities several forms of fog gage have been proposed though none of them have come into practical use. One suggested many years ago by G. J. Symons consisted of a white wooden screen, placed at a distance of 20 feet from the observer, on which were painted five black strips of different widths, the visibility of each strip corresponding to one of the five degrees of the fog scale. At night this was replaced by a lantern in front of which were to be placed five thicknesses of colored glass; these were to be successively removed until the light became visible at a distance of 20 feet. A more elaborate form of apparatus proposed by J. W. Lovibond in 1907 was based on the power of selective absorption resident in suitably colored glass and measured the brightness of a fog on a scale of thirty two tintometrical light units.

During the past year the Meteorological Office has been making experiments to determine more precisely the distance of visibility at sea by day and night corresponding to the five degrees of the official fog scale. The figures of the scale are based upon the interference of the fog with traffic and it is desirable to form some definite idea as to how far off a vessel or light is visible first when a fog-horn is sounded by navigators as a matter of ordinary precaution and secondly when extreme caution is judged to be necessary. The matter has been taken up with the Elder Brethren of Trinity House and arrangements have been made for observers at six lightships to note the state of atmospheric obscurity according to the numerical scale as judged by the requirements of traffic and at the same time to note the distance of known land and sea marks which are visible or invisible. The returns from the lightships are now being examined in the Meteorological Office and will form the subject of a special report.

Capt. R. E. Peary, famous for his expeditions in Arctic regions culminating in his discovery of the North Pole has deposited in the United States National Museum the series of sixteen gold and two silver medals that have been awarded to him. They include especially the great gold medal of the National Geographic Society of Washington presented to him for his discovery of the North Pole and the great gold medal of the Royal Geographical Society of London designed by Mrs. Scott wife of the leader of the British South Polar Expeditions and presented to Capt. Peary for Arctic Exploration 1886 1909. Also the following gold medals from American societies: The Cullum medal (first award 1892) and the C. P. Daly medal of the American Geographical Society of New York (first award 1902) the Hubbard medal of the National Geographic Society (first award 1906) the Elisha Kent Kane (1902) and the special medal (1909) of the Philadelphia Geographical Society and the Helen Culver medal of the Chicago Geographical Society (1910). The foreign medals received by him include the following all of which are of gold except the two specially indicated as of silver: Royal Scottish Geographical Society (1897) silver Royal Geographical Society of London (1898) Nachtigal medal of the Imperial German Geographical Society Hauer medal of the Imperial Austrian Geographical Society (silver) the Paris Geographical Society David Livingstone medal of the Royal Scottish Geographical Society (1903) King Humbert medal of the Royal Italian Geographical Society (1909) Royal Geographical Society of Belgium (1909) Royal Geographical Society of Antwerp (1910) and the Royal Hungarian Geographical Society (1910). Capt. Peary has also deposited in the National Museum the flag of his college fraternity which was presented to him by his brothers of the Delta Kappa Epsilon and the Peace Flag which was presented to him by the ladies of the Society of the Daughters of the American Revolution. Both of these flags he carried to the North Pole.

European Transformer Towers

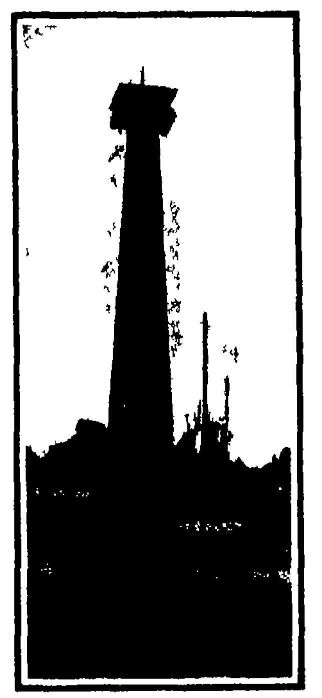
A New Type of Small-Sized Station

By the Berlin Correspondent of the Scientific American

A very suitable type of small-sized transformer station has been developed by the Oerlikon Machine Works which shows a number of advantages over masonry stations Apart from a considerable reduction in first cost and the possibility of readily shifting the station whenever required they are in fact fitted up completely at the factory and after being installed on their foundation are got into working order merely by connecting up the primary and secondary conductors as well as the transformer Owing to their pleasant exterior and small space requirements these stations can be installed anywhere in the midst of other buildings the more so as their painting can be adapted to the surroundings

Transformer towers are generally made of frame work comprising at the base a cabin for receiving the transformer and apparatus being designed as lattice poles they are of a very pleasant appearance and afford a point of support both safe and simple for use in connecting up any kind of conductor

TRANSFORMER TOWER HIGH TENSION SIDE



GENERAL VIEW OF TRANSFORMER TOWER

TRANSFORMER TOWER. LOW TENSION SIDE

The cabin is so designed as to afford ample space for a straightforward arrangement of all the apparatus and conductors It is generally fitted with two operating doors for the purpose of controlling the high and low tension ends respectively but can be as well made accessible from all four sides The most up-to-date apparatus have been provided for the protection and superintendence of the transformer

A galvanized sheet-iron tube 30 to 60 centimeters (11 81 to 23 62 inches) in diameter is used for introducing the primary conductors into the cabin. At each of its ends a cast iron spider is fitted in its interior and it carries the tightening device for three or six bare copper wires. The sheet iron tube below the upper roof of the tower rises to a height sufficient to prevent any rain from penetrating into its interior and accordingly into the cabin The secondary conductors (14 wires as a maximum) are taken out of the cabin by porcelain pipes protected against rain by a special roof which at the outside of the sheet iron tube are likewise arranged in the form of bare conductors.

The admission of fresh air is effected through apertures in the foundation a lively ventilation of the transformer being insured by the violent draught in the admission tube These apertures are arranged in the top part of the foundation, immediately below the iron foot of the tower Another arrangement which though somewhat more expensive is considerably better excluding as it does the entering of splash into the interior of the cabin, comprises an aperture closed with a perforated plate on one side of the foundation and through which a supply of fresh air below the transformer is allowed to penetrate directly into the cabin.

Any water oozing out in cold weather inside the sheet-iron tube is allowed to escape through an aperture in its lower end.

The transformer towers above described are designed in three sizes, the space available for the transformer having the following dimensions

Size	Length in meters.	Height in meters.	Width in meters.
A	1.0 (3.28 feet)	1.5 (4.92 feet)	0.7 (2.30 feet)
B	1.2 (3.94 feet)	1.5 (4.92 feet)	0.9 (2.95 feet)
C	1.3 (4.26 feet)	1.5 (4.92 feet)	1.0 (3.28 feet)

The largest size suffices for the installation of a transformer of fairly large dimensions, unless it be preferred to put up two small-size transformer towers, the secondary bus bar being provided with switches for use in allowing the transformers to work separately or in parallel.

In connection with another type of transformer tower, the whole iron structure is coated with 'Eternite plates fixed in position by zinc or copper sheets.

Electric Locomotives for Lotschberg Railroad

Two electric locomotives are now being built for the Bernese Alps railroad of Switzerland which crosses the mountains by the Lötschberg tunnel and makes connection between the northern Swiss railroads and the Simplon line Of the new railroad line there is already built a section at the commencement from Spiez to Frutigen The locomotives will be run upon this section and it is now being fitted with the trolley wire for this purpose The company will thus obtain the necessary data for building the standard locomotives which are needed Owing to the heavy gradients adhesion is a prominent factor while speed is of less consequence The Swiss Oerlikon firm is building a 2 000 horse power locomotive It works on single-phase current at 15 000 volts taken by trolley There are used two bogies each carrying one motor and three driving axles All the wheels are used for adhesion The 1 000-horse-power motor of each truck drives a countershaft by 1 3 25 ratio gearing Crank and bar drive is used to couple to the wheels All the wheels of one side are connected together in turn by crank and bar drive. A single motor thus drives the three wheels The same drive is used for each truck The total weight of the locomotive is 9? tons of which the electrical outfit represents 46 tons The wheels have a uniform diameter of 1 35 meters (4 45 feet) As to the mechanical part of the locomotive it is built by the Swiss Locomotive Works The second locomotive is built by the Allgemeine Electric Company of Berlin and the Krauss manufacturing firm An entirely different construction is used Two separate half locomotives each mounted on a three-wheeled truck are coupled together The truck in each case has two driving wheels on a side and one pony wheel When coupled the entire locomotive presents four driving wheels at the middle and a pony wheel at each end Weighing in all 102 tons is uses 75 tons for adhesion on the four axles The large wheel diameter is 1 27 meters (4 17 feet) and the small wheel 0 85 meter (2 79 feet) On each truck is an 800-horse-power single-phase motor of the German Winter-Eichberg type making 1 600 horse-power in all which is somewhat less than for the preceding type A reduction gearing to countershaft and crank drive thence to the wheels somewhat analogous to the above, is employed here The two wheels are coupled by a driving bar The present locomotives have about the same capacity as the Simplon locomotives which are built for 1 700 horse-power However there are radical differences in the design

Our Myriad Government Publications

Of 1 982 department publications issued, 25,160 469 copies were printed an increase of 46 2/3 per cent in the number of publications and 41 per cent in the number of copies The Superintendent of Documents sold 147,327 copies of the department s publications. The number of copies sold has increased 205 per cent within five years Of the Farmers Bulletin on 'Economical Use of Meat in the Home 47,148 copies were sold, although 900 000 were distributed free Forty-five new Farmers Bulletins were issued, with a total of 2,915,000 copies, reprints of older numbers aggregated 6,247,500 copies The expenditure for printing and binding was $441,249 94

A Novel System of Cleaning Water Mains

In a system of cleaning water mains invented by Mr R A. Adamson the engineer at the Rivington Works an opening of 9 feet is made in the main to be cleaned and a bracket is fixed on each end of the opening These brackets carry two rails and a screw of coarse pitch A gasoline engine is then lowered into the hole so that the wheels on the frame rest on the rails, while the screw passes through the center of the machine The shaft of the engine is then central with the main The frame of the machine is fitted with a hand wheel, by turning which the machine is propelled along the rails in either direction by means of the screw A specially constructed knife formed of a central bar carrying four cutters is used for the scraping, and is attached to the shaft of the machine. The engine having been started up, the driver turns the hand wheel in the desired direction of travel, the result being that the revolving knife is gradually fed into the pipe after the manner of a boring machine. The apparatus is such that in long lengths it is possible to clean 200 yards in each direction from the hole, or 400 yards in all The speed of cleaning is about 50 yards an hour or in ordinary practice an average of about 300 yards a day The appliance has been seen in actual operation at Huyton by a number of water engineers, while the members of the Liverpool Corporation Water Committee are so impressed with its labor-saving properties that they have decided to adopt it, and a machine has been ordered.

Apotheosis and the Worship of Ancestors

Eagle, Peacock, and Serpent and their Significance in Roman Times

By P F Mottelay

ONE of the prominent members of the French Academy of Sciences recently called attention to the recent discovery of funeral monuments of the early Roman period bearing novel designs of the eagle Jupiter's bird, which had taken the place of the Egyptian hawk and was made to play such a very conspicuous part in the Apotheosis (*Consecratio*) of Roman emperors

Very curious and singularly interesting are the comparatively little-known details of the origin and progress of the rite of deification or consecration which at one time obtained so extensively for the Cæsars

Apotheosis is the natural outcome of the progressive worship of ancestors The more the latter had distinguished themselves in private or in public life, the greater of course was the reverence paid them To rulers of men who are ever prominently majestically before the world will always deservedly attach that amount of admiration which their exalted position and their attractive surroundings necessarily command and the greater the popularity they achieve through personal valorous deeds or by means of victories obtained either on field or otherwise for the benefit and aggrandizement of their states as well as for acts benefiting their fellow men the greater naturally will be the honors and admiration accorded them by their immediate followers their family and their descendants

The founder for instance at his death became as others the common ancestor for all ensuing genera

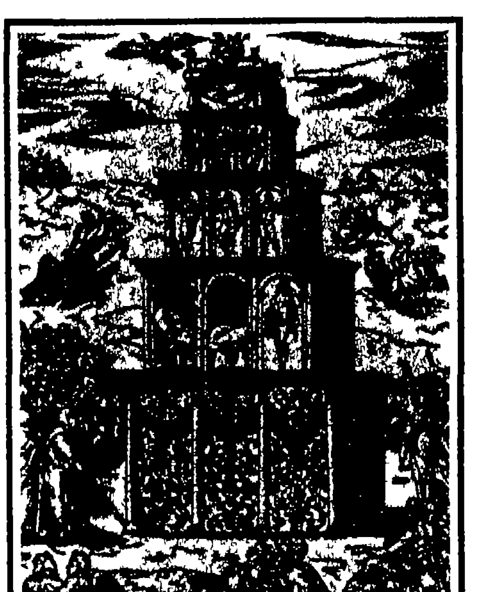


FIG 1—STRUCTURE BUILT FOR THE RITE OF APOTHEOSIS

tions and for the city he was what the earliest ancestor had been for the family His memory was easily perpetuated and later on in accordance with the customs prevailing yearly feasts were regularly held over his tomb and even sacrifices were made in his memory His fame grew at great pace and the increased honors attaching thereto which were gradually paid him extended afar so that beyond his original home and beyond his actual burial place as is pretty much everywhere the custom even at the present day honorary tombs and monuments were in due time erected to his memory As years progressed the story of the founder's deeds was amplified around it was weaved a more or less marvelous legend, while the poets and the writers consecrated it in records that were after awhile embellished and heightened to such an extent that the human original himself actually disappeared and he had become transformed into a being worthy of worship a god Thus it was Athens came to deify her two founders Cecrops the first king of Attica and Theseus the great hero of Attic legend Thus also Romulus founder and king of Rome, was proclaimed a god by the Senate as is well known, under the name of Quirinus

In Egypt where the ruling king was held as a god and was rendered anew all the honors bestowed upon his predecessors, the soul of the dead was first represented leaving the earth in the shape of a bird, then the bird was shown as carrying the soul itself. This idea of the soul-bird is borrowed from the stellar mythology teaching us that the sun is creator of souls by the sun is the soul created in human bodies and by the sun also is it recalled to heaven In Syria, the sun-god was himself represented borne upon the wings of an eagle It was at Hieropolis (Hierapolis) a city of Syria Cyrrhestica, that the goddess Atargatis had one of her most famous temples Atargatis was called by the Greeks Derceto and was worshiped

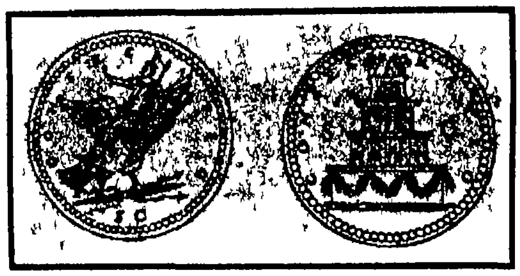


FIG 1—BRONZE MEDAL OF ANTONINUS PIUS FIG 2—REVERSE OF BRONZE MEDAL OF SEVERUS

under different names throughout pretty much the whole of Western Asia where are found many funeral monuments bearing an eagle the latter with outspread wings flying upward carrying a wreath in its beak or claws The wreath by the way denoted the victory of the soul over the evil one and it was said that the gods turned aside from those appearing before them without wreaths This silent form of deification at first prevailed everywhere but later on when the body of an illustrious dead was burned upon an altar an eagle was dispatched supposedly bearing heavenward the soul of the deceased This had been described by many authors but by none

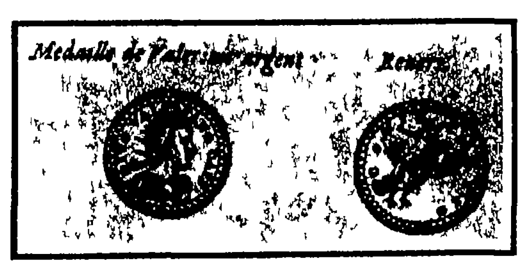


FIG 4—OBVERSE AND REVERSE OF SILVER COIN OF VALERIUS

more satisfactorily than by Herodian and Dion Cassius Their account of the customary ceremonies we think worth reproducing

There is placed in the palace vestibule upon a bed made of ivory and covered with a cloth of gold a waxen image of the dead representing him as still suffering and over whom guard is to be maintained for seven days At intervals during that period Roman Senators stand in black robes to the left of the image, while to the right and in white robes stand the ladies of the court and others holding high rank The doctors are daily in attendance and go through the form of recording the progressive decline in health of their patient until his death is finally announced When that is done the most distin

FIG 6—REVERSE OF BRONZE MEDAL OF FAUSTINA FIG 5—REVERSE OF MEDAL OF MARINIANA

guished dignitaries of the empire the senators and others carrying the couch bearing the real body likewise the bed holding the waxen image to the Campus Martius and place them upon one of the tiers of a high pyramidal structure which has been erected there covered with rich gold tapestries and ornamented by statues of ivory and by fine paintings and which has been filled with aromatic and other similar substances, with much incense and perfumes, as well as with offerings of all kinds This being concluded the court dignitaries and the military ride three times around the structure (*Decursio*) accompanied by chariots whose drivers wear flying purple robes and hold waving banners whereon are recorded the great deeds of happy rulers Then the reigning monarch fires the structure from the very top of which is allowed to escape an eagle mounting through flame and smoke into the sky for the purpose of carrying it is believed the soul of the dead from earth to heaven in order that the deceased may thereafter be worshipped with the other gods

It was in Rome that the apotheosis took its most regular form The first, after Romulus, upon whom apotheosis was officially conferred was Caius Julius Cæsar (100 44 B C) and after the victory of the triumvirs the senate bestowed upon him the name of *Divus Julius* the word *divus* having been employed in the same manner as *deus* The fact that during the brilliant ceremonies of his apotheosis a comet appeared was taken as a sign and to Augustus was proof conclusive that the soul of Cæsar had already been welcomed by the immortals C T Octavius Augustus (63 B C 14 A D) was the next to receive apotheosis and the ceremonies were the same as described by Herodian The fire it is said lasted five full days and into it the soldiers cast the arms borne by them during the ceremony as well as the medals and other rewards that Augustus had conferred upon them while the women cast in their jewelry and other ornaments and many of their vestments *Divus Augustus* was the name afterward given When apothe

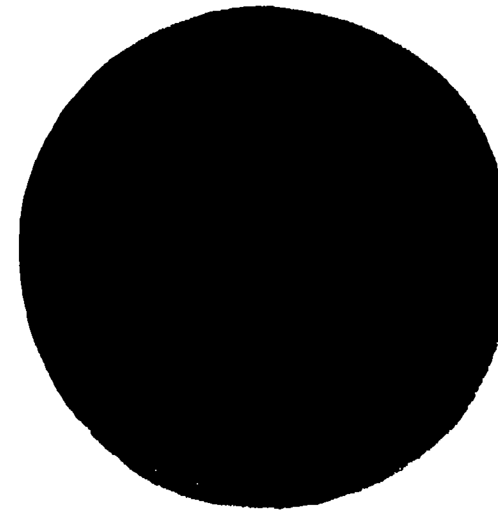


FIG 7—SUPERB BRONZE DISK FROM BRUSSELS MUSEUM SHOWING BAAL THE SUN GOD

osis was accorded to the emperor Antoninus Pius successor to Hadrian (86 161 A D) and to Faustina his wife (104 141 A D) two eagles were sent from the funeral pyre For the Roman emperor Publius Helvius Pertinax the Galba of his time successor of Commodus unusually fine ceremonies were observed His statue made of solid gold was carried upon a chariot drawn by elephants and the very high structure upon which the body was consumed was constructed of the finest woods and bore very many large ornaments of gold and of ivory This latter substance was by the way always used by the Romans for decorating the temples of the gods for the construction of thrones and for the ornamentation of the highest insignia

The English poet Dryden thus refers to the rite of apotheosis in the opening lines of Heroic Stanzas on the Death of the Lord Protector Oliver Cromwell (English Poets London 1810 vol viii p 498)

And now tis time for their officious haste
Who would before have borne him to the sky
Like eager Romans ere all rites were past
Did let too soon the sacred eagle fly

Incidentally it may be mentioned that the Greeks and the Hindus more particularly burned the bodies of their dead Among the Greeks it was the custom to burn the body after having bathed it in expensive oils and clothed it in most attractive vestments When the body was consumed the fire remnants were extinguished with wine then the ashes were sprinkled over with oils and with more wine after which the dishes were collected and placed in urns or other

receptacles The Hindus held fire as one of their gods (*Rig Veda* 11 1 7) under the name of *Agni* which carried the soul to the home of the blessed Like some of the other eastern people the Persians on the other hand did not burn their dead nor did they decorate the bodies with ornaments of gold that metal being of the color of the fire which they worshipped When a king died all the people of Asia were commanded to extinguish the sacred fire in their temples not to be relighted till after the funeral ceremonies The royal Persian tombs it may be added were always practically under guard that of Darius having thus been looked after for a period of seven years according to Ctesias (Herodotus vi 227)

In the accompanying illustrations taken from the excessively rare old work (C Guichard *Funérailles* Lyon 1581) found in the Sainte Geneviève library in Paris is seen at Fig 1 one of the forms of structure erected for the rite of apotheosis It shows the dead body of the king on the second tier the procession of chariots around the structure and *the eagle taking its flight In Fig 2 is represented* a different mode of structure upon the reverse of a bronze medal of Severus The other figures represent coins or medals of various rules showing the different forms in which the body was supposed to be taken heavenward Fig 3 is the reverse of a bronze medal of Antoninus Pius where the eagle is seen grasping thunderbolts Fig 4 gives the obverse and the reverse of a silver coin of Valerius Fig 5 is the reverse of a medal of Mariniana and Fig 6 the reverse of a bronze medal of Faustina In lieu of the design of an eagle the last two bear that of a peacock the favorite birds of Juno or Hera employed only when the apotheosis was that of an empress Upon the sides of a funeral altar in the Vatican can be seen the figures of G Pomponius Edaémon and of his wife Componia Helpis carried to heaven respectively *by an eagle and by a peacock*

In later days several emperors had medals struck showing the body taken by the griffin of Apollo (god of light god of the sun son of Jupiter and of Latona) and holding some attribute of the gods—the scepter thunderbolts or the *Fasta pura* The head of the emperor was sometimes made to bear a crown or it was surmounted by the nimbus and the body occasionally rested upon a throne or solar quadriga the latter being by the way admirably shown upon many of the coins and medals struck for the apotheosis of the much-esteemed emperor Flavius Valerius Constance Chlore father of Constantine

The eagle was ever a royal bird always employed as a symbol of force and of power It might be added that throughout heraldry it ranks as one of the most noble bearings in coat-armor

By the Persians, the eagle was placed upon spears as standards in the great battle of Cunaxa Babylonia B C 401 and it is said that the Romans adopted it for their legions during the second consulate of Marius their greatest general The first eagles were made of wood wreaths were soon added then these eagles were replaced by others made of silver with the bird resting upon golden thunderbolts up to the period of the Cæsars when the last-named gave way in turn to eagles made entirely of gold and deservedly *so for as Tacitus said (Ann II 17) the eagles* were by all considered the gods of the legions

Charlemagne introduced the eagle to denote that he held government over both the Romans and the Germans as shown upon the fine monument erected to him in the cathedral of Aix la-Chapelle As a sovereign emblem the eagle held its own throughout the fifteenth century and prominently because the emblem of the Holy Roman Empire The Napoleons also adopted it placing it upon the flagstaffs first between the years 1804 1814 afterward between 1852 and 1870 in accordance with a design of Isabey borrowed from the eagles to be seen upon the tombs of the Viscontis Some of these are in the Milan Cathedral which latter it may be added was begun in 1386 with brick cased in marble taken from quarries which the Viscontis gave in perpetuity

The eagle be it said is the fourth attribute of Christ denoting especially his divinity and his glorious ascension

In addition to the eagle upon funeral monuments we again find the griffin (part lion part eagle) as well as the serpent An unusually fine and very large Greco-Roman sarcophagus, brought to France in 11.., from Salonica, representing an episode of the war between the Greeks and the Amazons, is in the Gallery Denon of the Louvre Museum, and on it can be seen thick wreaths held by an eagle and two griffins. A serpent with an eagle s head is found carved on one of the tombs of the Porta Capena, and is reproduced in Tavola XXIX. of the attractive work published thereon by C L Ghassi. In the collection of antiquities belonging to the Bibliotheque Nationale Paris, are many notable cameos representing the apotheosis similar to those that are in the Vienna Museum and one of these shows an emperor carried to heaven by an eagle where he is about to be crowned anew with a wreath by an angel A fine sardonyx in Vienna is said to represent the apotheosis of Augustus, which is likewise represented in an attractive *basso-rilievo* in the chantry of the St. Vital Church in Ravenna Still more interesting is the bronze disk in the Brussels Museum (Fig 7) showing a serpent holding its tail and thus encircling the head of Jupiter, or more properly the head of Baal the sun-god of the Syrians Phœnicians, and heathen Hebrews, supported by a spread eagle whose wings appear as a luminous radiation

The serpent, when found upon funeral monuments is the symbol of renovation resurrection palingenesis He was made to represent those who had been deified From the highest antiquity he was classed among divine beings he was considered the guardian of sanctuaries In Egyptian mythology he is likened unto the sun i e life Among the Hebrews, the same word Héva signifies life as well as serpent. Among the Greeks the serpent biting its tail is the symbol of eternity for the serpent represents life and the circle thus formed is without end

It may be added that a very attractive emblem of eternity appears on many of the ancient monuments and upon medals or coins of Vespasian Titus, and others in the form of a woman holding in her right hand a head surrounded by rays to represent the sun and in her left hand a head bearing a crescent, to represent the moon such union of the two orbs of day and of night denoting the permanency of all time

Weighing the Earth, Sun, and Planets

The Mighty Scales of Mathematics

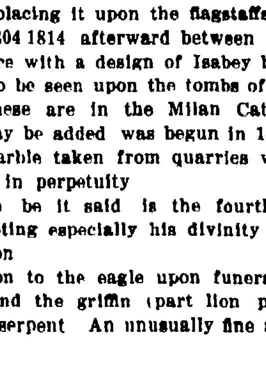
STRICTLY speaking says a writer in Kosmos the weight of an object is the force with which it is attracted by the earth This force is inversely proportional to the square of the distance from the earth s center Hence the weight of an object, as defined above and as measured with a spring balance is less at the equator than at high latitude and less on a mountain top than at the sea level The force of gravitation is proportional to the acceleration or rate of change in velocity of a body falling freely in a vacuum and the varying weight of an object as defined above is the product of its mass by the gravitational acceleration at the place of observation In the latitude of central Europe and the northern United States the velocity of fall *in vacuo* increases by about 32 feet, or 975 centimeters per second in each second of falling Hence the approximate numerical value of the gravitational acceleration (commonly denoted by the symbol g) is 32 in the English and 975 in the metric system

When an object is weighed on an ordinary balance with a set of standard weights however the result does not differ at different places because the object and the counterbalancing weights are equally affected by any variation in the force of gravity The operation is in fact a measurement of the mass of the object in terms of standard masses and this is what is commonly meant by weighing an object

Although we cannot put the earth in a scale pan we can weigh it with the aid of a balance

Prof Richarz filled a vault in the fortress of Spandan with 100 tons of lead and placed above the vault a balance from the pans of which two additional pans were suspended beneath the mass of lead by means of wires passing through vertical shafts which traversed the mass He found that two one-kilogramme weights which balanced when placed in the upper pans or in the lower pans did not balance when one was placed in an upper and the other in a lower pan although the additional weight required to restore the equilibrium was only about one milligramme The discrepancy was due to the attraction exerted by the mass of lead which pulled one of the kilogramme weights downward and the other upward From this experiment Richarz deduced the value of the gravitation constant, which expresses the force of attraction between two unit masses at unit distance from each other An idea of the magnitude of this force can be gained from the statement that the attraction between two masses each of one ton separated by a distance of one meter is nearly equal to the *weight* of 7 milligrammes The value of the gravitation constant in the C G S system in which lengths are expressed in centimeters masses in grammes and time in seconds is $6\ 7 \times 10^{-8}$

The attraction between two bodies varies directly as



WEIGHING THE EARTH WITH A BALANCE

the product of their masses and inversely as the square of the distance between them Hence the attraction between the earth and any object on its surface is $\dfrac{kMm}{\gamma^2}$ where k is the gravitation constant, M the mass of the earth m the mass of the body and γ the length of the earth s radius This attraction is equal to the weight of the object or mg where g is the gravitational acceleration Hence $\dfrac{kMm}{\gamma^2} = mg$, and therefore $M = \dfrac{g\gamma^2}{k}$

Substituting for g and k the values already given, and for γ the length of the earth's radius in centimeters, we find the mass of the earth, M, equal to 68×10^{26} grammes, or 68×10^{20} metric tons.

The volume of the earth calculated from its known dimensions is 12×10^{20} cubic meters Hence the density of the earth is about 5½ times that of water as a metric ton is the mass of a cubic meter of water

The mass of the sun is deduced from the attraction which it exerts upon the earth This attraction may also be expressed by the formula $\dfrac{kMm}{\gamma^2}$ but M now denotes the mass of the sun m the mass of the earth and γ the distance between the sun and the earth This attraction however is the centripetal force which holds the earth in its orbit and which is expressed by the formula $\dfrac{mv^2}{\gamma}$ in which v denotes the linear velocity of the earth in its orbit Hence $\dfrac{kMm}{\gamma^2} = \dfrac{mv^2}{\gamma}$ and therefore $M = \dfrac{v^2\gamma}{k}$ Substituting the values of v γ and k we find $M = 2 \times 10^{33}$ grammes or 2×10^{27} metric tons

The mass of the sun as thus determined is 325 000 times that of the earth The sun s diameter is more than 100 times and its volume is nearly 1,250,000 times, that of the earth Hence the sun is about four *times* less dense than the earth or not very much denser than water

The mass of any planet which has a satellite can be deduced from the distance and orbital velocity of the satellite as the mass of the sun is deduced from the distance and velocity of the earth The mass of a planet which has no satellite is obtained, less simply from the perturbations which it causes in the motions of other planets If the earth s mass is taken as unity, the masses of the other planets are Mercury 1/16 Venus ¾, Mars 1/9, Jupiter 300, Saturn 90 Uranus 13, and Neptune 16 The earth is denser than any other planet except Mercury The density of Saturn is less than that of water

The masses of the fixed stars can only be guessed from their relative brightness and distance and from the periods of rotation of some lunary systems, such as that of Algol in the constellation Perseus.

Exact measurements are out of the question.

INDEX OF INVENTIONS

For which Letters Patent of the United States were issued for the Week Ending January 17, 1911,

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Acid, production of compounds of persulfuric, G. Teichner 981,900
Acoustic diaphragms, making W. W. Young 982 027
Adding machine for cash registers, etc. F. L. Fuller 981,683
Addressing plate, U. G. Lee 982 076
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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October [illegible], [illegible], will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co Inc 361 Broadway, New York

Electrical Notes

Large electromagnets have been employed by ocu lists for more than twelve years, for the removal of splinters of iron and other magnetic metals that have entered the eye Two French surgeons regularly and successfully employ a very powerful electromagnet for the extraction of needles and similar foreign bodies from the tissues in general The needle—it is usually a needle—is first located very accurately by means of two X-ray radiographs taken in different planes. The electromagnet being then applied to the skin, in the most favorable position draws the needle to the spot and causes it either to emerge through the skin or to produce a little conical elevation of the skin. In the latter case it is necessary to make an incision less than half an inch in length in order to allow the needle to escape from the skin

Prof. Lippmann of Paris has been making researches upon electric contacts and finds that he can produce a contact without using pressure This may prove of great service for relay work as the problem in mak ing a sensitive relay consists in securing enough pressure to make the contact. It is known that when two metal pieces are in contact, a certain pressure is needed in order to make the current pass even when gold or platinum is used This causes the diffi culty in making a relay to work on very small cur rents as we cannot have sufficient contact without much difficulty Prof Lippmann sought to obtain a contact which would work without any pressure, and succeeded by using a metal on one side and an elec trolyte on the other A chloride of calcium solution answers very well and he uses a strip of letter paper wet with the solution and applied against a glass strip which serves as a support, immersing the lower end in a vessel containing the liquid so that part of the paper projects above The solution serves to keep up the moisture and it also brings the current to the paper He finds that the slightest contact between the paper and a metal piece is enough to make an electric contact This is proved by taking a gold leaf piece for the metal part. A galvanometer or relay in the circuit always works in this case and as the gold leaf is too flexible to give any appreciable pressure, the result is striking. Should a large surface of metal be used such a contact would stick and re quire some force to separate it. In some cases this would not be a disadvantage but in others the con tact surface should be small As to the use of mer cury it is known that a wire must be dipped well into the mercury in order to make an electric con tact However two amalgamated silver wires will make contact without pressure on the above principle provided the surface is kept wet with mercury

According to a note in *The Electrician*, a standard gage light railway at Gummersbach has recently been electrified The railway is intended principally for goods and carrying ore, but there will also be a few passenger trains High tension three-phase current at a pressure of 10 000 volts and a frequency of 50 will be obtained from the local electricity works and transformed by two 150-kilowatt motor generators to con tinuous current at 750 volts for supply to the trolley wire The railway is ten miles long the maximum distance from the transformer station being five miles The goods consist for the most part of stone from the stone quarries, which is only carried in one direction, so that only fairly empty wagons have to be drawn against the gradient. Owing to this circumstance the average consumption on the continuous-current side is only 160 watt-hours per ton-mile. The goods trains, which consist of six standard open wagons, are drawn by locomotives weighing 20 tons and fitted with two [illegible] horse-power motors, without causing any great variation of load at the transformer station. A comparison between the two systems of working—steam and electricity—shows that the latter is more efficient.

Alcohol

Its Manufacture
Its Denaturization
Its Industrial Use

The Cost of Manufacturing Denaturized Alcohol in Germany and German Methods of Denaturation are discussed by Consul General Frank H Mason in SCIENTIFIC AMERICAN SUPPLEMENT 1550

The Use, Cost and Efficiency of Alcohol as a Fuel for Gas Engines are ably explained by H Diederichs in SCIENTIFIC AMERICAN SUPPLEMENT 1596 Many clear diagrams accompany the text The article considers the fuel value and physical properties of alcohol and gives details of the alcohol engine wherever they may be different from those of a gasoline or crude oil motor

In SCIENTIFIC AMERICAN SUPPLEMENT 1581 the **Production of Industrial Alcohol and its Use in Explosive Motors** are treated at length, valuable statistics being given of the cost of manufacturing alcohol from farm products and using it in engines.

French Methods of Denaturation con stitute the subject of a good article published in SCIENTIFIC AMERICAN SUPPLEMENT 1599

How Industrial Alcohol Is Made and Used is told very fully and clearly in No 3, Vol. 95, of SCIENTIFIC AMERICAN

The Most Complete Treatise on the **Modern Manufacture of Alcohol**, explaining thoroughly the chemical principles which underlie the process without too many wearisome technical phrases and describing and illustrating all the apparatus required in an alcohol plant is published in SCIENTIFIC AMERICAN SUPPLEMENTS 1603 1604 and 1605 The article is by L Baudry de Saunier, the well known French authority

In SUPPLEMENTS 1607, 1608 1609 we publish **a digest of the rules and regulations** under which the U S Internal Revenue will permit the manufacture and denaturation of tax free alcohol

A Comparison of the **Use of Alcohol and Gasoline in Farm Engines** is given in SCIENTIFIC AMERICAN SUPPLEMENTS 1634 and 1635 by Prof Charles F Lucke and S M Woodward.

The Manufacture, Denaturing and the Technical and Chemical Utilization of Alcohol is ably discussed in the SCIENTIFIC AMERICAN SUPPLEMENTS 1613 and 1636 by M Klar and F H Meyer, both experts in the chemistry and distillation of alcohol Illustrations of stills and plants accompany the text.

The Source of Industrial Alcohol, that is the Farm Products from which alcohol is distilled, are enumerated by Dr H W Wiley in SCIENTIFIC AMERICAN SUPPLEMENTS 1611 and 1612 and their relative alcohol content compared

The Distillation and Rectification of Alcohol is the title of a splendid article by the late Max Maercker (the greatest authority on alcohol) published in SCIENTIFIC AMERICAN SUPPLEMENTS 1627 and 1628. Diagrams of the various types of stills in common use are used as illustrations

In SCIENTIFIC AMERICAN SUPPLEMENT 1613 the **Uses of Industrial Alcohol in the Arts and in the Home are discussed.**

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Trade Notes and Formulas

The following recipes and formulas are published simply as suggestions Chemicals vary, for which reason it is not always possible to comply with the conditions stated, or for us to guarantee the accuracy of the recipes A little experimenting, however, will easily enable the interested reader to ascertain just what modifications are necessary to meet his requirements —Editor of SCIENTIFIC AMERICAN SUPPLEMENT

Weather Foretelling Pictures.—Production 1 part chloride of cobalt 10 parts gelatine, 100 parts water, which gives blue color, 1 part chloride of copper, 10 parts gelatine, 10 parts water, for yellow, 1 part chloride of cobalt, 0 75 part nitrate of nickel, 0 25 part chloride of copper 20 parts gelatine and 200 parts water gives green Soften the gelatine in water, add the preparations and melt over a gentle fire

To Mark Tools.—Coat the tools to be marked with a thin covering of wax or hard tallow by heating the steel, rubbing the wax over it while warm until it melts and then allowing it to cool Now scratch the mark in it with a sharp instrument and pour on nitric acid rinsing the acid off with water after a time finally heat the metal until the wax melts and wipe it off The mark appears as though engraved.

Manifolding Drawings and Documents (according to Alfred Astfalck) —A sheet of paper blackened with iron gall nut ink and moistened with sulphate of ammonia, is covered with another sheet on which is written or drawn with ink that is a non-conductor of electricity Both sheets, between conductive plates are exposed to an electrical or galvanic current and the first sheet is then washed with water The effect is produced by the electrolytic decomposition of the ink

To Transfer and Fix Drawings on Ivory and Vegetable Ivory —The picture to be transferred is printed as a negative by lithographic process in a black fatty ink on a paper prepared for transferring in the well known manner By transfer printing the picture is placed on the article to be decorated The latter is rinsed in clean water and finally light being excluded is passed through a solution of nitrate of silver, then exposed to the effects of daylight. The parts free from fatty color are thereby tinted dark, the black color is washed off with exclusion of light by rectified oil of turpentine and the object immersed in a solution of hyposulphite of soda. Various colors may be obtained by the use of different substances sensitive to light, and by the use of baths of varying strength

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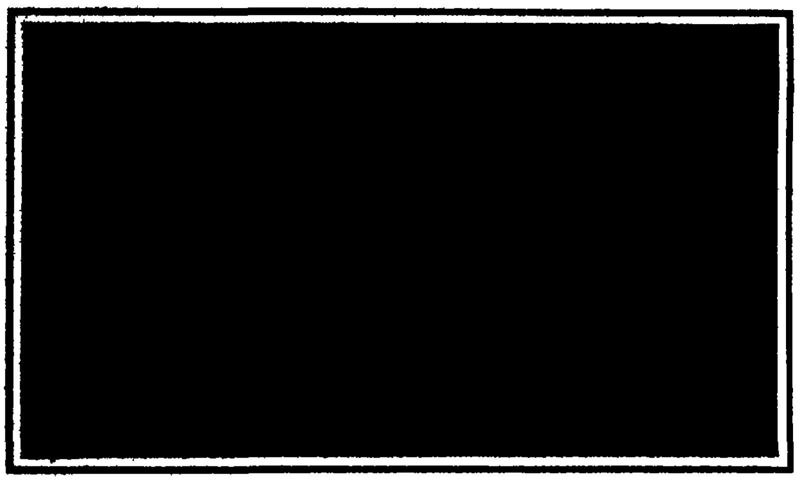

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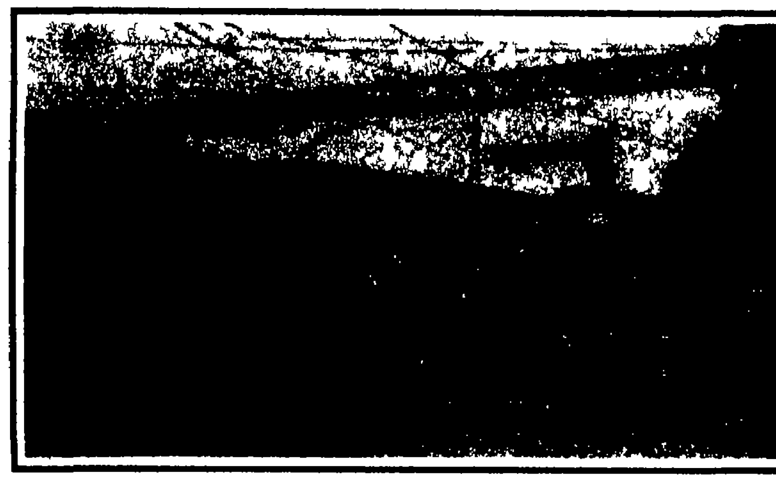

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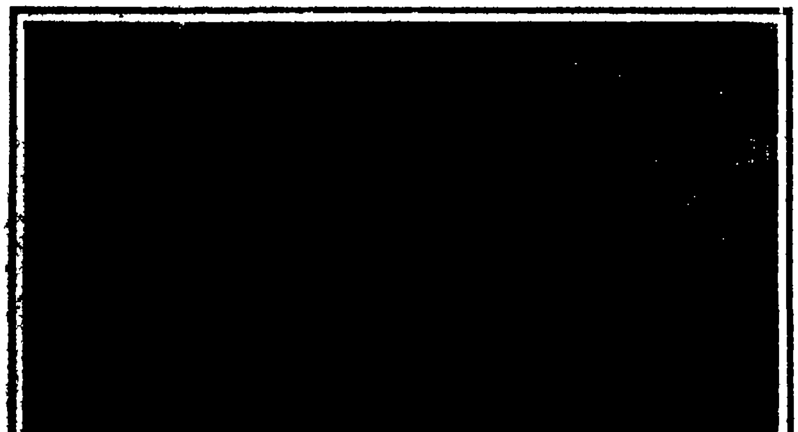

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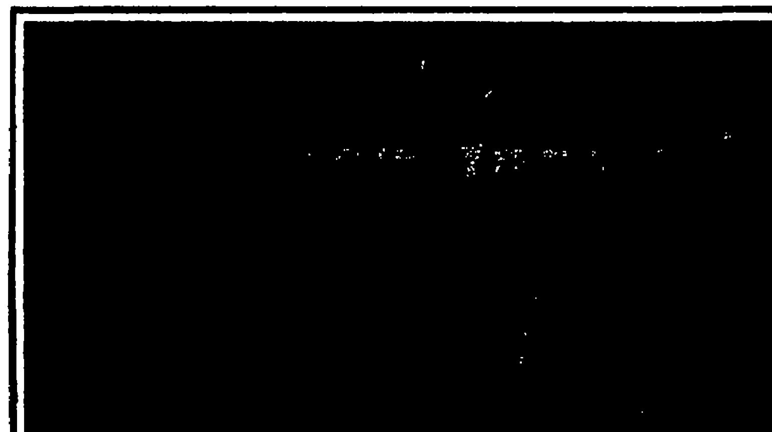

SHIELD OF BERLIER TUBE CONSTRUCTION OF NEW PARIS SUBWAY

THE NEW PARIS ELECTRIC SUBWAY

A New Electric Subway in Paris

The North-South Line

By the Paris Correspondent of the Scientific American

Paris now has a new line of electric subway in operation and it is likely to prove a favorite with the public While it is laid out on about the same general plan as the Metropolitan subway whose different sections run through the city it was constructed and operated by an entirely different company As regards the tunnel work of the line which is known as the North South subway we would refer to an account which we previously published at the earlier stages of this construction illustrating the steel tube tunnel running under the Seine We also present some views which were taken of the tunnel and other parts of the work at a later period than those accompanying our former article The remainder of the views showing the subway in its finished state the trains etc were taken at the time of the official inauguration of the line early in November On this occasion the Prefect of the Seine and delegates representing the ministerial department of public works the Municipal Council and other official bodies made a visit to the line and on the following day it was opened to the public

For most of the way there is used a double track tunnel the tracks being standard gage and employing the third rail system for taking the current Each track however runs in a separate tube when passing under the Seine In addition to the third rail an overhead wire is run along the tunnel and the motor cars are run by trolley as well as on the third rail system Short side tracks are placed at intervals in the tunnel which is here enlarged to receive them so that in case of obstruction to the track the trains will not be stopped in the main part of the tunnel but can be sidetracked

It will be remembered that the North South line was organized on an entirely different financial and operating basis from the regular Metropolitan subway Some years ago the plans for the Metropolitan were drawn up so that when finished it would cover the whole town by its different sections as nearly as this could be realized When entirely completed which will take several years to come there will be no less than 70 miles of subway in operation However it was noticed that a gap had been left in certain quarters of the town and it would be desirable to cover this so as to connect the southern quarters of Vaugirard and Montparnasse with the northern quarter of Montmartre For this reason the North South company was formed quite outside the Metropolitan system in order to have the new subway constructed more rapidly than would otherwise have been the case

The total length of the line when finished will be about 9 miles At present it ends shortly after the St. Lazare railroad depot and the remainder is at present in construction There are now finished 18 stations starting from the Versailles Gate and running by the Montparnasse Depot crossing the Seine at the Place de la Concorde and reaching the St Lazare Depot. When completed there will be 30 stations in all It was specially desired to connect the two railroad stations so as to give a more direct transit between these two points

Profiting by the experience already obtained in running the older subway during the last few years the North South line has a number of minor improvements which will be appreciated by the public The cars did not need to be changed over from single truck to double bogie as was the case for the Metropolitan line and involving considerable expense as did also the adoption of fire-proof motors after the very disastrous fire at the Couronnes station where so many passengers lost their lives by being smothered by the smoke from the burning train In the present case the cars are run from the start upon double bogie and all the most recent improvements have been made in the motors and controling apparatus The motor cars are built on the plan which follows the most approved practice that is the cabin is located at the car end and is quite partitioned off from the rest of the car with a small access door The remainder of the car is devoted to seating and standing places, on the central passage system following about the same plan as for the other subway Motor cars and trailers go to form the train the trailers differing only in the absence of the cabin Good lighting and ventilation add to the attractiveness of the cars The first and second-class cars have scarcely any difference except that they are painted outside in buff and blue color respectively

A general elliptical section is given to the stations and they are reached by staircases which descend from openings in the pavement These openings cannot be housed over as a general rule owing to the obstruction which they would give to the view Some difficulty was found in the old line in obtaining a suitable non slipping material for the steps when they were made wet by rain For the new line pressed carborundum has been used for this purpose It is very durable and at the same time excellent in preventing slipping As the line crosses the different sections of the other subway at four different points it was required to make the transfer in the proper manner so that passengers can go from one line to the other

Each subway has a separate station and these are connected by underground passages No extra charge is made in any case for the transfer the price of tickets being 3 cents for second class and 5 cents for first class on both lines Before 9 o clock there are delivered to employees return tickets for 4 cents, which allows of a return at any time of day

At the St. Lazare railroad depot there has been constructed an underground rotunda hall which is used as a centering point for the numerous passageways These are needed for the two subway stations, the passage leading to the railroad station and the street entries and exits One part of the rotunda is here represented It is surrounded with recess windows which are to contain displays of different kinds. In the center are the ticket offices and newstands The hall has a vaulted ceiling upheld upon columns and its design is tastefully carried out Another station at the Rue Falguière is worthy of remark from the fact that it is built of reinforced concrete We have already illustrated this work and it will be remembered that the present material was adopted on account of the narrowness of the street between the house foundations The side walls of the elliptical station had to be very thin in order to keep the same standard inside space The problem was very well solved by the use of reinforced concrete so that a side wall of but 0 61 meter (2 feet) could be employed

The stations are lined with white enameled brick and the name of the station is shown in large letters of colored brickwork Owing to the difference in the colored brick trimming of the station green or brown passengers can see at a glance which are the stations for making transfers The present tunnel does not run in a loop at the terminals as before but the trains are simply reversed these being adapted for running either way One of our views shows the train at the station yards which lie outside the tunnel near the Versailles gate A somewhat novel feature is the use of a combined third rail and overhead trolley system for operating Here the third rail is insulated and carries one side of the current while the other pole of the current is connected to the overhead wire using the ground (or track rails) as the common return

This gives a three-wire system and 1 200 volts are used in all in order to operate the two 600 volt motors of a car in the same way as two 110-volt lamps are coupled upon the 220 volt three-wire system In the case of the two motors one side of motor No 1 is thus connected to ground or the track rail and the other side to the third rail Motor No 2 is connected on one side to ground and on the other to the trolley wire The load is about even on each motor owing to the controller combinations By this method 1 200 volts are used on the current mains and consequently on half the current for the same power as if 600 volts were used and this reduces the size of the wiring

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RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR EDWIN GOULD

1 A prize of $15 000 has been offered by Mr Edwin Gould for the most perfect and practicable heavier than air flying machine designed and demonstrated in this country and equipped with two or more complete power plants (separate motors and propellers) so connected that any power plant may be operated independently or that they may be used together

CONDITIONS OF ENTRY

2 Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines in which the arrangement of the engines and propellers is clearly shown with the mechanism for throwing into or out of gear one or all of the engines and propellers Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize 361 Broadway New York City Each contestant in formally entering his machine must specify its type (monoplane biplane helicopter etc) give its principal dimensions the number and sizes of its motors and propellers its horse-power fuel-carrying capacity and the nature of its steering and controlling devices

3 Entries must be received at the office of the Scientific American on or before June 1st, 1911 Contests will take place July 4th 1911 and following days At least two machines must be entered in the contest or the prize will not be awarded

CONTEST COMMITTEE.

4 The committee will consist of a representative of the Scientific American a representative of the Aero Club of America and the representative of some technical institute This committee shall pass upon the practicability and efficiency of all the machines entered in competition and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional The decision of this committee shall be final

CONDITIONS OF THE TEST

5 Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others and that he is able to couple up all engines and propellers and drive them in unison No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight over a designated course and for a period of at least one hour he must run with one of his power plants disconnected also he must drive his engines during said flight alternately and together Recording tachometers attached to the motors can probably be used to prove such performance

In the judging of the performances of the various machines the questions of stability ease of control and safety will also be taken into consideration by the judges The machine best fulfilling these conditions shall be awarded the prize

6 All heavier than air machines of any type whatever—aeroplanes helicopters, ornithopters, etc.—shall be entitled to compete for the prize but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition

7 The flights will be made under reasonable conditions of weather The judges will at their discretion order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable

8 No entry fee will be charged but the contestant must pay for the transportation of his machine to and from the field of trial

9 The place of holding the trial shall be determined by the Contest Committee and the location of such place of trial shall be announced on or about June 1st 1911

Lieut. Bouvet has been making excavations at the Roman *castellum* of Ras-el-Ain Tlalet in the North African region owing to a subsidy received from the Tunis archæological department It is a fortified place of square shape of about 200 feet on a side The walls are 5 feet thick and are rounded at the four corners like the fort of El Hagueuf Doors are observed on the north and south sides, but not in the center The construction resembles that of the ancient camps of the Roman legion. Cavities below the ground level are found which appear to be Christian tombs. One of these 7 feet deep, contained a square pitcher and a Christian lamp Probably the tombs were violated in ancient times. A chamber resembling a cellar was also found, and it contained the débris of about thirty amphoræ with numbers printed on them Lamps, coins, and vases were found in this place.

The Armament of Battleships

Sir William White s Views

THE general principles of warship designs belong to no one nation. It needs however the practical as well as the theoretical experience of past years gained both at sea and in office of experimental work afloat and ashore and of design work tempered by the judgment of its unbiased users to produce a ship especially one for purposes of war in which every thing is not only placed to the best advantage but which shall simultaneously possess the important quality of fighting power associated with peace time convenience and habitability Just at the present moment when the competition in naval armaments has pressed to the very utmost the output resources of the great armament firms in England Germany and the United States the views of Sir William White, as they appear in an interesting paper on the subject of battleship armaments to the Society of Naval Architects and Marine Engineers in New York are of more than usual interest Sir William has probably designed more warships than any other naval architect and his views have invariably been expressed with a temperate logic that goes far to carry conviction in the face of marked and able differences of view enunciated more emphatically but almost inevitably based on shorter experience of the subject under discussion Sir William s views in his latest paper indicate very clearly that his reputation for clarity of exposition has lost none of its force since he resigned the position of Chief Constructor to the Royal Navy

The arguments in the paper under discussion reflect very fairly the views of the two camps into which gunnery schools may be said to be divided One is the all big gun one-caliber school while the other advocates a secondary armament for battle purposes As Sir William points out at the beginning of his paper the fundamental idea which has governed the armaments of warships in all ages is the desire to provide means of offence which will enable a ship to destroy her adversary in the shortest possible time with the minimum damage to herself and active offence still constitutes the best though not the only means of doing so The best arrangement of armament for this purpose is discussed largely on the lines of Sir William s criticism of Admiral Bacon s paper on the Battleship of the Future read before the Institution of Naval Architects in London early in 1910 and more space being at his disposal on this occasion the pros and cons of the Dreadnought type are comprehensively analyzed and deliberate opinions expressed as a result Let it be said at once that Sir William advocates the re adoption of the 6 inch gun as a fighting weapon in association with not more than four twin center line turrets arranged as in the South Carolina an arrangement which it is said is to be adopted in the new Japanese battleship now being built at Barrow Whether the big gun advocates will believe that in the latter case the secondary armament is for fighting or for anti torpedo boat purposes is another matter Their view was given in these columns some few weeks ago in a leading article on the resuscitation of the medium caliber weapons

It is generally agreed that battle ranges have inevitably increased of late years owing to the development of the locomotive torpedo and to systems of fire control associated with improved gunnery Conflicting views are held as to what the range will be Climatic conditions and a serious intention of attaining a decisive issue may tend to reduce the range that would be chosen by the faster all big gun ships Herein lies the crux of the situation When the earlier Dreadnoughts were built their speed gave them the advantage of choosing the range Now that there are numerous ships of this type as well as much faster torpedo craft afloat there is as we pointed out in the article referred to a strong tendency to develop the smaller weapons But for what purpose? Not for battleship attack directly For indirect attack for keeping up a blanketing' fire with the object of making it difficult for the enemy to see the attacking ship and on the off chance of their effecting damage to unarmored structures and communications which in fluence fighting efficiency they may be useful but it becomes a question as Admiral Bacon said as to whether adequate value for tonnage involved is obtained by their adoption Obviously if they are installed at all they can be used for any or all purposes as long as they remain in action The volume of fire obtainable from such quick firing would some say inflict considerable damage and the experience of the Russians at Tshushima is generally dragged in to prove it It is in this case Well in Capt Semenoff's book quoted in the paper under review we find on page 124 the remark That s only a 6 inch no more portmanteaux now' —the word referring to the Japanese 12-inch shell Again on page 135 There was a loud crash this was not a 6-inch shell, but the portmanteaux again The men became seized with panic Semenoff tells ably of the utter destruction due to shell fire but his words are apt to be misread the heavy shell was what they feared and a similar well directed fire from the Russian ships—secondary or primary or big torpedo —would have kept the Japanese much farther away obviously leaving the action even more to a question of portmanteaux With this practical experience in view it is impossible to reconcile Sir William s reason for believing that actual trials do not confirm the objection to mixed armaments on the ground that the simultaneous discharge of guns of different calibers must be accompanied by diminished efficiency in the control of fire and in the proportion of hits to rounds made by guns of different calibers As we stated some time ago when gun fire is handled so as to obtain hits not merely volume of fire the rapidity of discharge is much below the possible rapidity of fire of the gun Admiral Bacon suggests that it is merely a quarter of the potential rapidity and aptly remarks that rapidity of fire unaccompanied by rapidity of hitting is a futile waste of ammunition We hold most strongly that in the King Edward class for instance the accuracy of 6 inch fire is materially affected by the simultaneous discharge of the 9 2 inch and 12 inch guns It suffers also in rapidity from the smoke nuisance

In referring to the number of heavy guns to be mounted Sir William advocates pairs and goes on to note the extraordinary Italian practice of mounting three triple and two twin turrets in the Dante Alighieri class Triple turrets involve insuperable objections to practical gunners of the hit the target order besides being too many eggs in one basket they suffer from smoke interference and throw off to an excessive extent The relationship of protective material and the adequate support of the same also receives attention In many foreign vessels we find turret roller paths fixed directly to or supported on the vertical barbette armor—a most dangerous practice as in action the combined efficiency of the heavy gun armament in spite of heavy blows on the protective armor is a primary consideration Adequate clearance between fixed and moving portions of a turret should always be allowed in spite of the increased overall dimensions and weight necessary Reference is made to the maximum number of heavy guns that should be carried by a warship Here the author is on much safer ground In tonnage value for effect obtainable it is hard to believe that it is possible to improve on the arrangement first adopted in the United States battleship Michigan of four twin turrets on the center line the two inner turrets firing over the two end turrets Such an arrangement possesses the great advantage of minimum interference between turrets due to 'blast The system adopted in the Inflexible class in the Von der Tann or the Spanish battleships of having two center line and two echelon turrets really reduces these vessels in practice to the status—considering broadside work only—of six gun ships On paper the echelon arrangement allows three pairs of turrets to fire ahead and astern on the keel line On board such a discharge causes unpleasant consequences and the limits of safe training in practice are considerably less than the extremes shown on the drawings Of course automatic danger signals —generally shrill buzzers by the side of the turret training levers are supposed to warn the gun layer when he risks his own or his neighbor s comfort from blast but these are extremely apt to be unreliable in action and the system of mounting guns to avoid this even if the number of heavy guns be reduced will probably be found best in service The advantage conferred by confining the primary armament to the ends of a ship as far as magazine accommodation is concerned is very considerable Side turrets as in the Dreadnought or Minas Geraes are inconvenient—the Nassau is very bad with four large turrets crowded together owing to the difficulty experienced of making a good boiler and engine room arrangement Sir William does not touch on the point beyond referring to the objection to mixing stokeholds and magazines but it entails probably an additional row of boilers to make up for the staggered units cut out by an echelon arrangement or an increased length over the machinery space to allow for a transverse magazine This involves a corresponding addition to the length weight and cost of the heavy belt armor In view of this and the question of interference his deliberately expressed convictions that in no case is it desirable to mount more than eight heavy guns in a single ship and that these are best arranged in four positions as in the Michigan class will meet with less criticism than his third view that they should be supplemented by a powerful and well protected secondary armament

A large number of naval officers want a protected 6 inch battery reintroduced in spite of their expressed conviction that its fire may be discounted at ordinary battle ranges when accompanied by a 12 inch gun fire Here is where Sir William takes an opposite view A secondary battery mounted as in the Michigan on the upper deck is in our opinion vastly better than the corresponding main deck battery of the Delaware With however the smoke nuisance from the heavy guns the continual anticipation of blast effect from overhead and the lower rate of fire inevitable from these causes as well as from the desire for accuracy it is hard to agree with him The naval desire for the reintroduction of the 6 inch gun arises from a belief that it is a better anti torpedo gun than the 4 inch Opinions on this point also differ widely If the increased caliber of heavy guns tends to put up battle ranges then it probably is but as we stated in the article we referred to the 4 inch should also be retained in our opinion for mounting in the superstructure

At the conclusion of his paper Sir William turns to the important point of future gun caliber and draws a trenchant parallel between present practice and that of twenty years ago All the arguments that held good for the increase from 12 inch to 13 5 inch hold good for an early advance to 15 inch or 16 inch Such a gun is being made we believe at the present time No argument is raised against such a caliber except that of larger or more costly ships This has never been heeded Warships of all kinds are generally smaller than merchant vessels and for many years the largest have never exceeded about 60 per cent of the greatest mercantile displacement There are at present at least four ships being built with over 60 000 tons full load displacement and an increase in war ship size is inevitable in the early future So it is with speed The Von der Tann and Lion will set examples of a far reaching kind Nothing is said of the tactical influence of speed or armament in the paper under review but it is obviously considerable Meanwhile in spite of Sir William s generous treatment of the subject we feel assured that the big gun school adhering to the results of their practical experience will remain unconvinced that for fighting purposes anything less than the biggest convenient gun is worth having —*The Engineer*

MR. H E. WIMPERIS M.A Assoc M Inst. C E before the British Association for the Advancement of Science described the form of accelerometer recently invented by him The instrument consists of a brass box about 4 inches across containing a copper disk mounted on a vertical pivot and damped in its motions by a permanent magnet. The c.g of the disk is purposely removed from the axis so that when the box moves forward one side of the disk tends to lag behind thus partially winding up a coiled spring and actuating a pointer which moves over a scale To render the reading unaffected by any accelerations at right angles to the direction of motion a second parallel axis is fitted which is geared to the first one and has attached to it masses having the same mass moment as the disk itself Couples about these two axes add up in the direction of motion but neutralize one another in any direction at right angles The accelerometer therefore reads in one of the three directions of space only and is not affected by even violent movements in the other two directions With this instrument the author has measured the road resistance of various classes of road and has obtained figures varying from 50 pounds to 210 pounds per ton On main line railways the resistance is usually from 12 pounds to 20 pounds per ton depending on the speed Measurements have also been made of the resistance to motion when a motor car is coasting In this way the horse power and the engine friction can be measured and a figure for the mechanical efficiency be obtained

The conclusions reached may be summed up as follows By the use of the accelerometer road resistances can be read off at sight the air resistance of the various shapes of car body can be determined the brake horse power and indicated horse power of the engine can be obtained for various speeds and that it is possible to trace step by step the losses of power in transmission to the road wheels

Some Notes on Telephony*

Facts and Principles Underlying Modern Practice

By H Harrison, '07

I

In writing this article it is my object to bring together concisely such fundamental and general information pertaining to telephony which is not readily available to the technical man not directly engaged in this phase of engineering activity

Of the many telephone systems in operation no one can be said to typify universal practice Each has some peculiarity which renders it especially adaptable for some particular situation not possessed by the other Fundamentally however all of the systems are alike it is only in the devices employed to get successful results that practice varies so widely With this in view the text circuits and sketches will aim to emphasize general principles only

II

Any variation of resistance in a circuit will pro-

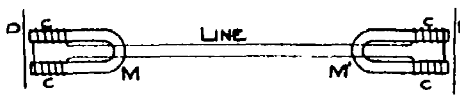

Fig 1

duce a variation of current upon this principle depends the successful electrical transmission of speech The *variation of current* is the essential point Fig 1 illustrates this M and M are both permanent magnets The coils cc and cc are wound around the ends of these magnets and are connected in series with the line D and D are soft iron diaphrams Normally the magnetic flux produced by M and passing through the coils cc remains unchanged Any change in this magnetic flux will induce an electromotive force in cc and this in turn will produce a current in any circuit with which cc may be connected Voice waves upon striking D will cause it to move to and fro thus varying the distribution of the magnetic flux set up by M and producing currents in cc These currents will vary (1) in strength according to the intensity of the motion of D and (2) in direction according as D is moving toward or away from M Such a *variation of current* in cc will cause the magnet M to be correspondingly strengthened and weakened thus exerting a varying pull on D and reproducing the original voice waves faithfully

In the scheme outlined above the talking currents are produced by virtue of the transmitter acting as a generator or dynamo the power for driving the dynamo being derived from the particles of air engaged in constituting the sound waves The currents so produced must of necessity be very weak and therefore only effective for comparatively short lines To overcome this defect a transmitter has been devised which depends for its action on causing variation in the strength of a current generated by an outside source The variation of current is obtained by making use of the principle that if the pressure between two conducting bodies forming part of an electric circuit be varied the resistance of the path between them will also be varied Fig 2 illustrates this

The current from the battery passes through the

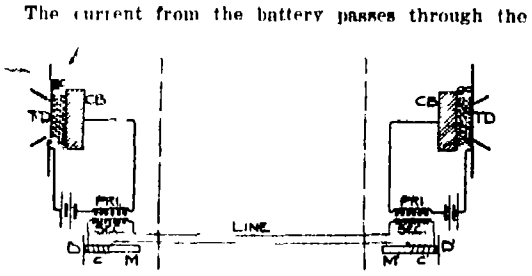

Fig 2

primary of an induction coil and through a mass of granular carbon gc which lies loosely between a carbon block CB and the diaphragm TD Any sound waves striking TD will produce a slight to and fro motion of the diaphragm which will cause the resistance of gc to vary This variation of resistance will cause corresponding changes of current in the primary circuit thus inducing currents in the secondary which pass over the line and affect M and M' (both acting as receivers) as has been explained under Fig 1

It might be well at this point to call attention to the fact that the varying current in the primary of the induction coil is undulating in character and always in the same direction The secondary current is however alternating in character its direction depending on whether the primary current is increasing or diminishing in strength Then again by virtue of the large size of wire and the small number of turns in the primary winding of the induction coil and the comparatively small size of wire and the large number of turns in the secondary winding a comparatively high voltage is available with which to send the talking currents over long lines of high resistance

Fig 2 embodies all the elements essential for the effective transmission of articulate speech There is lacking however a signaling system so that an individual at one instrument can call the attention of an individual at another instrument in the same system when communication is desired For such a purpose the magneto hand generator in circuit with a polarized bell is very largely used and affords a most reliable signaling apparatus Fig 3 illustrates this

The magneto hand generator is an alternating current machine depending for its action on the principle governing the action of all dynamo-electric machines i e that if the number of lines of magnetic force passing through a closed coil be varied currents of electricity will be generated in this coil the direction of these currents depending upon the direction of the lines of force and on whether their number is decreasing or increasing

The armature A is wound with a large number of turns thus permitting the variation in the number and direction of the lines of magnetic force that pass through it in its various positions as the crank C (Fig 4) is turned The lines of force are produced by the permanent magnet NS (Fig 3)

The bell shown in Fig 3 is a polarized bell NS is a permanent magnet c and c are soft iron cores connected by the yoke y also of soft iron and on which the bell caps are mounted The bell hammer is rigidly fixed to A which is so pivoted that its ends may move freely toward c or c according to which is the stronger magnet The alternating current from the magneto periodically strengthens and weakens the magnetism induced in c and c by NS so that one end of A is alternately attracted more strongly than the other which makes the hammer strike alternately the two bell caps

The bell and the armature winding are connected in series with the line (see Fig 5) Hence any ringing current coming from the line meets the resistance of the magneto This resistance which is appreciable would weaken the ringing current considerably To remedy this special devices are provided which short circuit the armature when the magneto is not in use

Fig 4 illustrates this Here the short-circuit is made between p and p by the contact at d which is held in place by a spring As soon as the crank C is operated p' is pressed away from p by means of another spring When C has ceased to turn the short circuit is re established

III

Enough has been said to make plain along what lines certain fundamental electrical principles have been utilized in telephony By way of emphasis a brief summary will prove useful

Prof A G Bell is given the credit for constructing the first successful telephone instrument His success was due in a great measure to the fact that he realized fully the importance of a basic principle announced at the time by Lord Kelvin viz that If electricity is to convey all the delicacies of quality which distinguish articulate speech the strength of its current must vary continuously as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound The make and break principle used by many experimenters could not be made to meet the above requirements To get a current which would vary continuously and in simple proportion to the velocity of sound Bell made use of two electrical principles (as explained under Fig 1) (1) that, if the intensity of a magnetic field inclosed by a conductor be in anywise varied a corresponding varying current of electricity will flow in said conductor (transmitter) and (2) that if a permanent magnet be under the influence of a varying current this current will, according to its direction increase or diminish the inherent attractive force of said magnet (receiver)

Bell's instrument proved a striking success (its essential features being embodied in present day receivers) It lacked however the capacity to generate a current of sufficient strength to contend with high resistance lines To overcome this defect the carbon transmitter based on the theory of varying pressure (as explained under Fig 2) was devised by Edison whose ideas are embodied in present day transmitters.

It has been pointed out that a variation of resistance will produce a variation of current That this is the general principle underlying the transmission of speech may now be thoroughly appreciated by re-reading the text pertaining to Fig 2

A general assembly circuit embodying all the necessary features of an elementary telephone system is shown in Fig 5 Here if M wishes to talk to N the crank of the generator G is turned (switch hook H

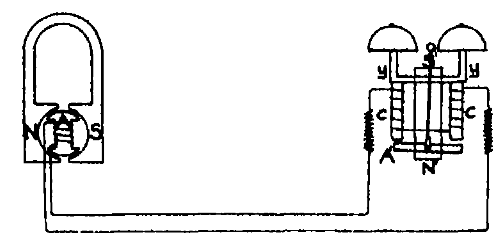

Fig 3

down) ringing current passes out on the line through switch hook H to the bell B and back to its source (G) by way of the shunt (Fig 4) attached to G B and B ring at the same time M now takes his receiver off the hook and waits for N to answer

If O who is in the immediate vicinity wishes to establish telephone communication with both M and N an instrument is placed on his premises with separate pairs of wires going to the respective instruments of M N and O When there are more than two or three instruments some form of sliding contact lever key is also provided at each instrument for placing any two stations in circuit. Fig 6 indicates the form such lever key arrangements may take With the key in its normal position M is always in circuit with every station in the system If M wishes to call say L the key must first be moved to the position indicated by the broken line Contact is thus broken at n o l and q and M is in circuit with L only

It is along lines similar to the above that what is known as an Intercommunicating System is established Such systems in a variety of forms are in common use in offices factories hotels etc where the number of stations does not exceed say twenty five A greater number than this necessitates such an amount of wiring and complication of circuits as to make the system both expensive and cumbersome

IV

Considerations of a technical commercial and practical nature have made the Central Station method the only successful one for handling a large number of telephone stations Here every telephone station has but two wires which terminate in a central office where an operator is provided with suitable devices for placing any two stations in circuit

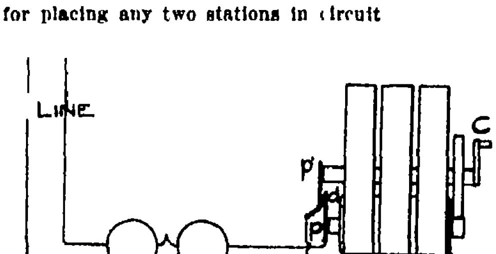

Fig 4

Central offices may be divided into three general classes

1 Automatic
2 Magneto
3 Common Battery

Automatic central offices aim to do away either entirely or in part with the services of operators Here, the central office equipment is very complicated and does not permit of sufficient flexibility At the present time there are comparatively few automatic systems in operation

Magneto central offices are not subject to the above objections, but here the subscriber's equipment (which is as indicated under Fig 5) entails an outlay of dead capital (local battery and generator), the maintenance cost per instrument is excessive (battery needs frequent attention), and the subscriber is

required to perform duties which are burdensome and inconvenient (holding switch hook down and operating hand generator to "ring" central) Magneto systems are being rapidly replaced by common battery systems, which though by no means perfect, yet possess those elements which stand for convenience electrical efficiency reliability, economy and flexibility

The basic elements of a common battery system are shown in Fig 7 The subscriber's equipment consists of a transmitter receiver induction coil (not shown) switch hook polarized bell and condenser The subscriber's pair of wires terminate at the central office switch board in what is termed an answering jack The subscriber's lamp with its battery is connected to the answering jack springs as shown Normally the lamp circuit is open on account of the condenser which is a bar to the passage of unvarying currents

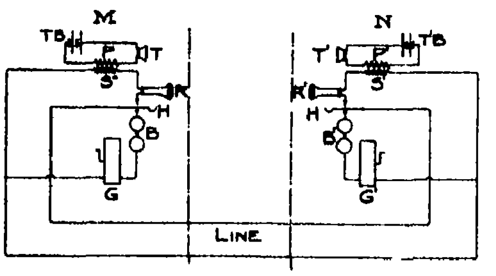

Fig 5

The common battery or talking battery is wired in multiple between the answering and calling cords Each pole of the battery is connected to these cords through a divided repeating coil one limb of each cord being connected to one of the four windings of the repeating coil The operation of a transmitter in circuit with either cord will produce a varying current which will act inductively through the repeating coils upon the other cord

Thus if A wishes to speak to B he takes the received off the hook and unconsciously makes contact at d which lights his central office lamp On seeing the light the central office operator inserts the plug of the answering cord into A's jack and puts her telephone instrument in circuit with A by pressing the talking key (As an incident to the insertion of a cord plug into a jack the jack springs are pressed away from the lamp circuit contacts thus putting the lamp out) When A tells the operator that he wants B she inserts the plug of the calling cord into B's jack and presses the ringing key This sends alternating current out on the line through the condenser (which is no bar to alternating current) and the bell When B takes his receiver off the hook communication between A and B is established

When B is transmitting the windings $c\,c$ will operate as the primary windings of a transformer of which the secondary is formed by cc The variation of current produced by B's transmitter will act inductively through the repeating coils and produce a corresponding variation of current in A's circuit thus actuating his receiver

V

There are few industries in the United States which have made more rapid progress than that of telephony. The first successful telephone instrument was introduced by Prof Bell in 1876 Early in 1877 the manufacture of telephone instruments took definite form and by the end of the year there were about 60 000 instruments in use This enormous progress (although the percentage rate of increase has been greatest in the past few years) has been continuous

The report for 1907 shows that the Bell system has about four million subscribers and that the actual value of Bell plants and working capital is $589 000 000 Gross earnings for the year amounted to $120 000 000 The number of local messages averages eighteen million daily the number of long distance messages nearly a half million daily

The above figures would perhaps be enlarged once over if reports from all the independent companies were available

The figures would tend to indicate that with the great capital invested the number of persons employed must be enormous and that therefore telephony as a field of effort must rank among the leaders

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The California ground squirrel is costing the country millions of dollars because of its destruction of grain, fruits and nuts and its tunneling in irrigation embankments. In May, 1910 it caused a break in the Turlock Canal in Stanislaus County which cost $25,000 to repair, in addition to the loss of the use of the water, estimated at over half a million dollars Still more important is the fact that the ground squirrel has become plague-stricken and unless vigorous measures are used for its destruction the disease may become endemic as it is in India among certain of the native rodents There is danger that the disease may be communicated to human beings and spread to other States The most effective means of destroying the ground squirrels has been found to be whole barley coated with a starch solution holding strychnine in suspension With this preparation the squirrels may be practically exterminated over large areas at a cost of from 3½ to 6 cents an acre depending on their abundance This preparation may be safely employed in pastures on sheep ranges and along public highways The poison should be administered before the breeding season

The Corrosion of Iron

We have no intention of troubling our readers by jejune remarks on the importance of the matter on which we indite The point of interest for engineers is the cause of the corrosion which destroys their structures for the reason that the cause being found remedies may be provided

Hitherto there have been two rival schools with their respective scholars and an academy with a scholiast at its head which and who are now dismissed The schools are known as the carbonic acid and the electrolytic schools and put briefly their doctrines are these The carbonic acid exponents believe that the rusting of iron is conditioned by the interaction between the metal and the oxygen of carbonic acid which in the presence of water forms ferrous carbonate this being decomposed by further oxygen to form ferric hydroxide and to liberate carbonic acid which is the evil emissary laying the iron open to attack The upholders of the electrolytic theory maintain that the intervention of carbonic acid is an accident and unnecessary as a mode of explanation They hold that pure iron has in itself a solution tension—in plain words a tendency to dissolve—in pure water just enough to cause it to displace the hydrogen of that water to form a solution of ferrous hydroxide and to produce rust when this solution is exposed to oxygen—from air it may be Experiments are given by both protagonists diametrically opposed The believer in the electrolytic theory states categorically that he has been able to dissolve pure iron in pure water his opponent shows with great exactitude that pure iron is unattacked by pure water even in the presence of oxygen but on the incursion of the merest trifle of carbonic acid corrosion occurs and proceeds Honest thanks are due to both these honest workers and from the conflict of their opinion something useful may be picked

It is a fundamental fact that in a system composed of the pure substances iron water and oxygen the oxidation of the iron should take place because the energy of the system is thereby degraded It is also known that to upset the equilibrium of such a system which may be unstable some *quantum*

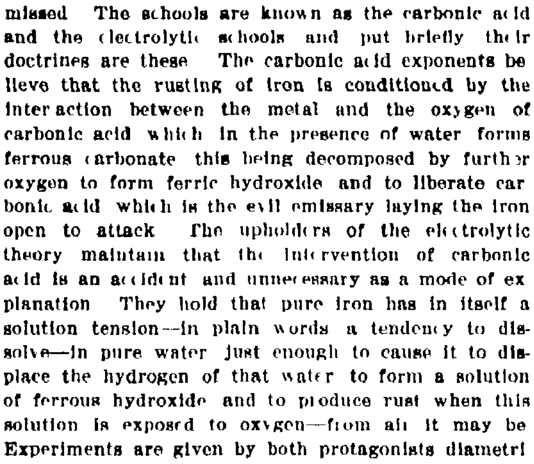

Fig 6

quid may be needed This in the present instance may be termed an electrolyte Water when as pure as the chemist can secure is so nearly a non-electrolyte that its influence may be dismissed But any ordinary water condenser water and still more the natural water which in practice commonly comes into contact with iron contains abundance of electrolytes Pure iron is no doubt, homogeneous in the fullest sense but no one who has looked at the polished surface of a piece of commercial iron—and *a fortiori* steel—under the microscope would hesitate to pronounce it miscellaneous in texture As neither pure iron nor pure water ever come together in practice it may be pretty safely assumed that these two materials in the presence of oxygen will suffer ordinary corrosion and in this respect the electrolytic advocates are right although their experiments were designed to avoid such *contretemps* as commercial iron and common water *Per contra*, the carbonic acid dialecticians have proved their point almost to the hilt by working with precautions bearing the most remote relation to those obtaining in a boiler When the sides are balanced and when all proper allowance is made for the serious difficulties of experiment—difficulties which can scarcely be appreciated by any who has not himself encountered them—the matter according to our present knowledge may be summed up thus

Commercial iron including all forms of steel, is a heterogeneous body Ordinary water contains a variety of salts which are electrolytes In the presence of oxygen the iron will be oxidized as thermochemical considerations require The rate of oxidation will depend jointly on the degree of heterogeneity of the iron and on the amount and completeness of dissociation of the electrolytes But as in every natural water carbonic acid exists and as it can act as

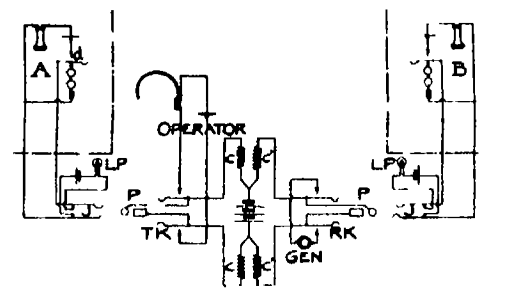

Fig 7

a labile acid uniting with ferrous hydroxide and being expelled from that combination by oxygen (ferric hydroxide being formed) again to take up its role as a constituent of ferrous carbonate it is pre-eminently fitted to serve as a destroyer Iron in the ferric state is sufficiently basic to hold most other acids but carbonic acid it cannot hold and thus it turns the emissary back to do further mischief In practice both causes of destruction are at work the heterogeneity of the iron and the liability of the carbonic acid—the presence of an electrolyte being understood

Formulation of our present knowledge and description of its foundation is easy but what about the remedy? It is best to say at once that none exists As long as the heat of combination of iron with oxygen remains at 68 000 cal and as long as these two elements are in contact with one another so long will iron rust provided a few necessary conditions occur and these are so ordinary that their existence may be assumed In special cases it is possible to prevent the corrosion of iron by making it passive or by making it electronegative but these are rare enough to be put as instances and not as examples In most cases the engineer has already decided that the provision of a skin which shall block the passage of oxygen to the iron is the best mode but as his idea of a skin usually resolves itself into one of paint the outcome is generally poor Certainly it may be improved by the use of more rational preservatives than paint such as tar applied as hot as it can be got upon the structure But this is scarcely a help in protecting the inside of a boiler and if it be admitted as it must be admitted if any fragment of our knowledge is right that the destruction of a clean unprotected boiler of any sort fed with clean ordinary water is certain then thankfulness may be felt that clean ordinary water commonly provides its own protection for the boiler in the homely form of scale

There is no royal road Iron is won by the expenditure of fuel and is potentially a combustible Wherever it meets oxygen it will endeavor to unite with it The rate of union is neither here nor there the tension making for union remains As that tension is elemental and invincible the only means for its frustration is a severance of the two bodies by an impermeable septum and as our friends the electrochemists have given us such valuable help in this matter we crave their aid for its provision

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Wedgewood Ware is a peculiar glazed or unglazed earthenware goods first made in England by the potter Josiah Wedgewood and named after him In coloring Wedgewood ware in the mass the Jasper ware for instance consisting of

Heavy spar	150	40	0	[illegible]0	32	160
Kaolin	35			1[illegible]	10	60
Blue clay	45	20	12	35	25	90
Fire clay	35		3	10	8	40
Gypsum	6				1	8
Cornish stone	50	20	20		7	
Bone ash				2[illegible]		

Add coloring metal oxides Blue 0 , oxide of cobalt dark green 1 part chromic oxide blue green 0 3 chromic oxide and 0 3 cobalt oxide light green oxide of nickel bluish green oxide of copper yellow antimony yellow brown in place of flux add to the plastic clay about 0 33 of calcined ochre (iron dross) and about 8 parts of manganese

What Electrochemistry is Accomplishing—II*

Modern Methods and their Results

By Joseph W Richards

Concluded from Supplement No 1830, page 51

III Electric Furnaces

Electric furnaces are furnaces in which the necessary heat or degree of temperature is produced or attained by means of electrical energy The electric current is used in these furnaces solely for its heating or thermal effect and either alternating or direct current may be used but alternating is preferred because of its easier generation and management capability of being procured from transformers and absence of electrolytic effects

Electric furnaces render remarkable and highly valuable service to the chemist and metallurgist for two distinct and unique capabilities they can generate heat within themselves without the use of combustion and the consequent products of combustion to complicate the working of the furnace and they can besides if desirable produce temperatures absolutely unapproachable in furnaces using fuel and thereby enable the carrying out of operations only possible at these extremely high temperatures The upper limit of electric furnace temperature is simply the volatilizing point of carbon the temperature at which the material of which the lining of the furnace is made is boiled away This is about 3 700 deg C or 6 692 deg F The simple statement that this is three times as high as the melting point of cast iron may give some notion of the enormous temperature here at one s command Besides high temperature the efficiency of application of electrical heat to the useful purpose is usually high in many cases 60 to 75 per cent of all the heat developed can be usefully applied as against 5 to 50 per cent utilized in fuel fired furnaces The heating value or thermal equivalent of the electric current is perfectly definitely known one kilowatt hour will furnish 860 calories (3 400 B t u) which if applied usefully at 100 per cent efficiency would bring to boiling and convert into steam 1 35 kilogrammes (3 pounds) of water or bring to melting and melt about 3 kilogrammes (6 6 pounds) of cast iron or 2 5 kilogrammes (5 5 pounds) of steel

Artificial graphite is a product particularly electrochemical in its manufacture Your fellow townsman Dr E G Acheson has practically created this industry and his name sticks to the product—Acheson graphite No temperature but that of the electric furnace can convert the ordinary amorphous carbon containing small amounts of foreign substances into pure soft, homogeneous unctuous graphite The purity of the product and its quality has even surpassed the artifice of Mother Nature herself Whereas before graphite in small scales was laboriously gathered from Ceylon and Siberia and with great pains worked up into graphite articles now the articles are simply molded in ordinary impure amorphous carbon and converted through and through retaining their shape into finished and complete graphite articles What this highly pure product is going to do for lubrication for annihilating the friction of the world s machinery perhaps only a few suspect and only Mr Acheson knows You will all know more about this soon and everyone of you who uses machinery will profit by it Meanwhile in another direction probably half the electrochemical industries now operating are beneficiaries of this invention using artificial graphite anodes in electrolytic operations or as electrodes in electric furnaces The electrochemical industry in general has been most wonderfully helped by this one electrochemical process

Carborundum stands for a large industry centered at Niagara Falls and founded also by Mr Acheson Twenty years ago the name was not in the dictionary now it is known all over the world as the most efficient abrasive material in use First produced just across the Monongahela in a little furnace as large as a cigar box and sold for polishing diamonds at many dollars per ounce it is now made by tons in electric furnaces of 2 000 horse power capacity and competes successfully with such common nature abrasives as emery and common sand And in fact common silica sand the most abundant material on earth with common carbon like coke furnish all the ingredients necessary for the furnace to work upon to produce SiC silicon carbide Mr Acheson not merely founded another new industry but he discovered a new chemical compound he has enriched science promoted industry and created new instruments of service no wonder that his scientific friends have showered on him honors—the Rumford Medal the Perkin Medal and two years ago the presidency of this Electrochemical Society

Silicon is the metal whose oxide is silica sand and is by far the most abundant metallic element on earth Up until very recently it was to be seen only in chemical museums costly and useless—a chemical curiosity Now Mr F J Tone one of Mr Acheson s former lieutenants is producing it by the ton and selling it by the carload at a few cents per pound The chemical world has found uses for it, large uses such as in solidifying steel making good copper castings reducing other metals from their oxides chemical pots and pans etc This illustrates again the variety of the achievements of electrochemistry Here is a new material furnished the world at a low price and all sorts of workers are finding all sorts of advantageous uses for it The electric furnace makes it from simply sand and carbon with electric energy, and plus considerable brains.

Calcium carbide is the product of another American invention The name was scarcely in chemical books and the purveyors of the rarest chemicals did not have it on their lists when Mr Thomas Wilson trying to make something else in the electric furnace made this compound from ordinary lime and carbon and started an electrochemical industry which has spread all over the civilized world I am almost tempted to say that there is a calcium carbide works everywhere but in Pittsburg but that would really be an exaggeration and I will not say it. The best thing about calcium carbide is that it is easy to make the raw materials may be found almost everywhere and wherever power is cheap a flourishing calcium carbide industry may be built up The curious thing about it is that its chief use is based on destroying it acting upon it by water and forming acetylene gas How great a boon acetylene gas has been to the bicyclist automobilist for lighting trains isolated houses stations and towns needs no recital before this audience but the value of acetylene as a means of welding with the blowpipe is only commencing to be appreciated Acetylene welding is a convenience which owes its existence entirely to the electrochemical production of calcium carbide and the iron and steel and other metal industries are being greatly helped by its use

Titanium carbide is not as familiar as calcium carbide It is made in a manner similar to the production of carborundum using titanium oxide (rutile) and carbon It has no uses similar to calcium carbide nor any like silicon carbide But electrical engineers have discovered that as arc light tips or electrodes it gives the most efficient arc light yet discovered with a light efficiency running up to 3 candle-power per watt of electrical energy This is probably 50 per cent of the theoretically possible conversion of electrical energy into light energy and is doubly as efficient as has ever before been attained What this means for street lighting everywhere is difficult to realize perhaps the best and most easily understood comparison is to say that the titanium carbide arc lamp is to the ordinary arc as the tungsten filament incandescent lamp is to the carbon filament lamp you will all grasp the scope of that statement. With acetylene lighting on one hand and titanium arc lighting on the other we need say no more about the influence of electrochemistry on modern illumination

Phosphorus I stated before that the potassium chlorate on safety matches was all being made electrochemically We can say practically the same of phosphorus The electric furnace enables us to distill phosphorus much more easily and safely from the natural phosphates than the older chemical methods Calcium carbide gives us acetylene gas and another electrochemical furnace gives us the phosphorus to strike the light."

Ferro-alloys are alloys of iron with the more expensive metals used in manufacturing steels of various kinds Ferro-manganese is used in practically all steel ferro-silicon is used in almost all Ferro-chromium nickel tungsten molybdenum boron, uranium, vanadium are some of the alloys used to make the special alloy steels such as find great use in rapid tool steel automobile axles armor plate, gun steel, etc These alloys are of great importance to the steel industry and are made almost exclusively in electric furnaces The industry has flourished most in countries having cheap power, such as among the French Alps and the importations into this country have been on a large scale Fortunately, we are commencing at Niagara Falls, in Virginia, and in Canada, to supply ourselves with these necessities of the steel industry, and we may look forward to a steady and large domestic development of this industry Within a few miles of this hall a small electric furnace is now at work making ferro-tungsten to go into high-class expensive steel Pittsburg is going to take its share in the running of this particular electro-metallurgical industry

Pig iron would seem to be about the last item to find a place in an address upon the electrochemical industries But the truth must out electric furnace pig iron is now being made and made and sold at a profit We will hasten to admit that the furnaces are small that they are in California and Sweden, where fuel is expensive and power is cheap that a great deal of money has been sunk in bringing them to their present condition but after all has been admitted the fact remains that electric furnace production of pig iron is not a chimera but an accomplished fact. Pittsburg has been able to boast that she "could manufacture a ton of pig iron and put it down anywhere in the world cheaper than it could be there produced That may be *still* true *of the kind* of pig iron which Pittsburg is able to make but there are grades and qualities of pig iron (Swedish charcoal pig iron, for instance) which are still imported into this country and sold at double the price of our domestic pig iron And in the country where that charcoal pig is slowly laboriously and skillfully made the electric shaft furnace is able to compete with the charcoal blast furnace in producing this high quality pig iron Dr Haanel of the Canadian Department of Mines has in a recent report given us the most reliable information about the running of this furnace The construction is peculiar and still somewhat experimental the full power for which the furnace was designed has not yet been available for running it the workmen are new to their tasks the overseers are still learning the irregularities in the running are not yet all overcome and many of the minor details are yet being adjusted The furnace is still in brief decidedly in the formative or experimental stage Yet notwithstanding Prof Odelstjerna one of the most expert of Swedish metallurgists states that the cost of production is $1 50 per ton less than in the Swedish blast furnaces If that is true now it needs little gift of prophecy to figure out at least $2 50 per ton saving when the furnace is properly run Three similar furnaces of greater capacity 2 500 kilowatts each are to be erected in Norway three similar ones are to be put up at Sault Ste Marie Canada. These are only the forerunners we may be sure of dozens or perhaps even hundreds which will be built and operated within the lifetime of most of this audience The time at our disposal forbids me describing these interesting furnaces I can only refer you to Dr Haanel s interesting reports and to the transactions of this society, particularly our volume xv One surmise of my own I will however take time to mention I have predicted that this electric furnace pig iron made without the admittance or use of air blast will be far superior to ordinary pig iron for conversion into steel because of the absence of oxygen or particularly, of nitrogen. *Time* will test this prediction too

Electric steel is at present a topic of absorbing interest and great potentialities It was primarily a competitor of the most expensive kind of steel—crucible steel It was first made commercially in 1900 by Mr F A. Kjellin of Sweden by melting together in an electric furnace the same high-grade materials which are usually melted down in crucibles to form crucible steel The product was made equal in quality to crucible steel It was produced in lots of a ton or more at a melt of very satisfactory uniformity and with cheap water power to furnish electricity the cost was considerably below that of crucible steel

The steel melting pot or crucible is a siliceous vessel holding about 100 pounds of steel, lasting only a few heats, and lifted in and out of the furnace by manual labor The consumption of fuel to get the required melting heat is wickedly wasteful, not over five per cent of the heat-developing power of the fuel used is efficiently utilized as heat in the melted steel, and the actual proportion is usually less than half that much The cost of labor crucibles and fuel is excessive, and to this must be added the high cost of the pure material which must be used—practically the purest iron which can be made.

The electric furnace is changing all this, rapidly in continental Europe, slower in Sheffield, and still

* An address delivered at the Seventeenth General Meeting of the American Electrochemical Society in Pittsburg, Pa and printed in the Transactions of the Society

slower in America, but the change is spreading surely and inevitably Real crucible steel will soon be a thing of the past supplanted entirely by electric furnace steel of equal quality made and sold much more cheaply

The electric furnaces used are of almost all types The induction furnace was developed commercially by Kjellin in Sweden improved enlarged and greatly developed by his associates in Germany combined with the Colby pattern in America, and still further modified by Hiorth in Norway Thirty-six of these furnaces, the maximum capacity being one at Krupp s works at Essen 8½ tons at a charge are now built or building The American Electric Furnace Company is organized to push their building and operation in America The arc radiation furnace was developed by Major Stassano an Italian artillery officer It melts by heat radiated from powerful electric arcs Several of these are in operation in Europe and a gentleman managing one of the large American steel companies who has just returned from an inspection of the different electric steel furnaces operating in Europe tells me that he considered the Stassano furnace as doing the best work all around of all the furnaces he saw in operation I have seen this furnace operating smoothly and regularly in Turin producing steel for castings which were being sold in competition with open hearth and Bessemer steel castings in the open market The single arc furnace is best illustrated by the Girod furnace which is built like the body of an open hearth furnace with the electric current entering the bath by carbon electrodes suspended above it and springing arcs to it while the current leaves the bath through metallic conductors passing through the saucer shaped hearth below the level of the metallic surface These furnaces work with great regularity and a large number are operating in Europe in capacities up to 12 tons each I am informed that the Krupp works at Essen has just contracted to put in five of these of the 12 ton size which would confirm statements made to me by my European friends that this furnace is working the best of all the electric steel furnaces now operating in Europe The double arc furnace of which the Heroult furnace is the most familiar type works with two arcs in series the current entering the bath and leaving it also through electrodes suspended above it The general style is that of an open hearth furnace with electrodes passing through the roof The current used is roughly 100 kilowatts per ton of steel capacity and the largest so far operated is 15 tons A three-ton furnace of this type was seen by you at the Firth Stirling Steel Works at Demmler yesterday producing crucible-quality steel The U S Steel Corporation has acquired licenses to operate the Heroult furnace and has already two 15 ton furnaces in operation Without doubt, the Heroult furnace is at the present time the most popular and successful electric steel furnace in the United States I have not time to more than name the Keller the Hiorth the Harmet the Frick—all of which are operating at this present moment in Europe

There are other ways of making steel than the crucible method Bessemer steel is the cheapest and open hearth steel is next best These two varieties grade into each other in quality but between open hearth and crucible steel there is an enormous gap in price and in quality which is destined to be bridged over by intermediate qualities of electric steel as it becomes cheaper and is manufactured on a larger scale This will soon become one of the large uses of the electric method occupying a field peculiarly its own It will enable steel manufacturers to supply steel better than the best open hearth product at less than the price of crucible steel I need not enlarge upon the advantages of this to a Pittsburg audience

There are also varieties of methods of manufacture of steel aside from the melting together of highly pure materials as in the crucible method which are equally available in most types of the electric furnace The Bessemer converter takes liquid pig iron as it comes from the blast furnace and by rapid oxidation by air blast converts it into steel Mr Heroult has tried to combine the Bessemer converter with the electric furnace in one apparatus the idea being to first oxidize the metal by air blast and then to finish it while electric current supplied the necessary heat I have no information that this combination furnace is anywhere in successful operation but the equivalent of the same operation performed first in the Bessemer converter and then on the blown metal transferred into an electric furnace for finishing is already in regular commercial operation at the South Chicago Works of the U S Steel Corporation I have had the privilege and pleasure thanks to Mr Heroult of studying that operation in company with Mr Heroult and the editor of Metallurgical and Chemical Engineering You may find a description of the process in the April number of that journal so I will not repeat it here—except so far as to say that 15 tons of the product of the Bessemer blow oxidized to the extent usual in the Bessemer converter was kept melted less than two hours on the basic hearth of the electric furnace treated with two different slags to refine it from phosphorus and sulphur deoxidized or dead melted and then poured into ingots of steel intended for axles The steel produced was of better quality than the usual corresponding open hearth metal and was produced at slightly less total cost This combination process bids fair to give a new lease of life to the declining Bessemer steel industry its economic importance is evident

The open hearth steel furnace is at present the most important of the methods of manufacturing steel—"tonnage steel It makes steel from pig iron and scrap of proper quality or from pig iron and iron ore (mill-scale) or from pig scrap and ore It makes its best steel on silica hearths from high grade material low in sulphur and phosphorus and its cheapest steel on basic hearths from almost anything The electric furnace can do any or all of these things and as a general proposition produce better steel from given materials than the open hearth furnace Under what circumstances it will pay to use the electric furnace instead of the open hearth furnace would take at least one lecture to discuss we will not go deeply into it here In Europe countries which have very cheap water power around $10 per horse-power year and fuel costing $4 to $6 per ton are finding the electric furnace the cheaper with power costing $20 and coal $5 the two are about on equal terms in Pittsburg with power at $30 and coal at $1 the open hearth furnace is by far the cheaper for producing such steel as it can produce However even here the combination of Bessemer and electric furnace is possibly cheaper than the all open hearth process the combination of open hearth and electric furnace process is quite possible and practicable to produce crucible quality steel on a large (tonnage) scale and the combination of the open hearth and electric furnace into one furnace is not only a possible combination but is actually being tried out

The latter idea is to take an open hearth furnace and to place electrodes in the roof The furnace is run as an ordinary open hearth furnace with the electrodes withdrawn and at the close of the open hearth heat gas and air are shut off entirely the electrodes lowered into proximity to the bath and the heat finished as an electric furnace heat The idea is sound and practicable and will result in the production of better steel than can be obtained from any open hearth furnace at but a slight advance on the cost of the open hearth steel say $2 to $3 per ton

As to the capacity for enlargement of electric steel furnaces they started out to duplicate the crucible steel process producing 100 pounds of melted steel at a heat and in eight years have risen to 15 tons capacity In Europe an electric calcium carbide furnace of 18 000 kilowatts capable of producing 200 tons of carbide daily is in practical operation A furnace of like power capacity could be built to make steel and would be a 200 ton steel furnace or larger We can therefore say with assurance that with a little more experience and experiment electrometallurgists will be able to furnish the steel maker with electric steel furnaces as large as are wanted—up to 200 tons capacity if desired

Polonium

POLONIUM was the first of the active substances separated from pitchblende residues by Mme Curie Various methods of concentration were devised by her with the result that preparations of polonium mixed with bismuth were early obtained many thousand times more active than uranium Marckwald later separated from 15 tons of pitchblende about 3 milligrammes of intensely active material which he called radio-tellurium since it was separated initially with tellurium as an impurity By dipping a copper plate into a solution of this substance he obtained a deposit of weight not more than 1/100 milligramme which was far more active than an equal weight of radium It was soon recognized that this preparation was identical with polonium for it gave off the typical α radiation and had the characteristic rate of decay of that substance Unfortunately Marckwald was not aware at the time of separation of the great importance of testing whether lead appeared as a product of transformation of polonium Before such an experiment could be made the polonium to a large extent had been transformed

Polonium is one of the numerous transition elements produced during the transformation of the uranium radium series It is half transformed in about 140 days emitting α particles during the process Rutherford showed in 1904 that polonium was in reality a transformation product of radium itself Radium at first changes into the emanation and then successively into radium A B C D E F radium F being identical in all respects with the polonium directly separated from a radio active mineral When the radium emanation is allowed to decay in a sealed glass tube, the walls of the tube are coated with an invisible deposit of pure radium D radium E and radium F, but the amount of the latter to be obtained in this way is far too small to be weighable

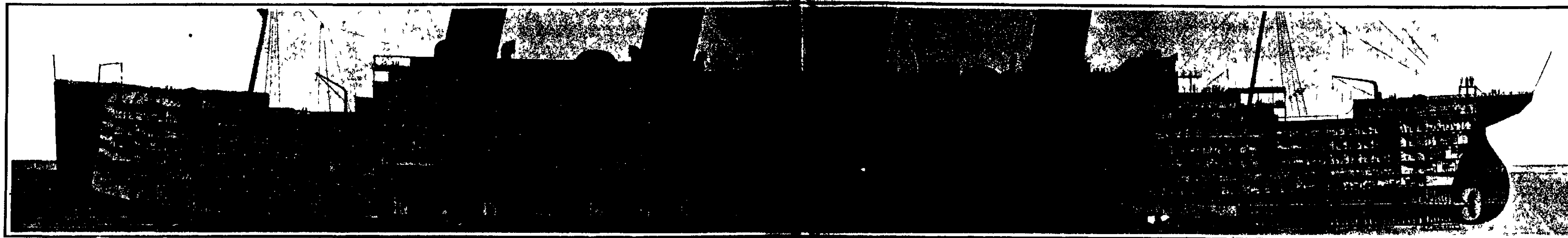
The amount of polonium present in any radio-active mineral can easily be calculated Since the radium and polonium (radium F) in a mineral are in radio-active equilibrium, the same number of α particles are expelled from each per second Since polonium is half transformed in 140 days and radium in 2 000 years the former breaks up 5 000 times faster than the latter The maximum amount of polonium to be obtained from a mineral is in consequence only 1/5 000 of the amount of radium In 1 000 kilogrammes of pitchblende containing 60 per cent of uranium there are present 170 milligrammes of radium The weight of polonium is about 1/5 000 of this or about 1/30 milligramme It is thus obvious that to obtain 1/10 of a milligramme of pure polonium several tons of high grade pitchblende must be worked up The most natural source of polonium is radium D (radio-lead) which grows polonium and has a period of half transformation of about twenty years Since polonium breaks up about 5 000 times faster than radium its activity weight for weight should be about 5 000 times greater than that of radium There is nothing surprising in this for the radium emanation has an activity about 200 000 times that of radium while radium A (period three minutes) must have an activity 400 million times that of radium itself Since the radiation from polonium is entirely in the form of α rays it is to be expected that the radiation from it would show chemical and physical effects identical with those observed for pure emanation the only difference being that the products of the latter emit β and γ rays as well

Apart from the interest of obtaining a weighable quantity of polonium in a pure state the real importance of the present investigations of Mme Curie lies in the probable solution of the question of the nature of the substance into which the polonium is transformed This problem has been much discussed in recent years Since polonium emits α particles one of its products of decomposition as for all the other α ray products should be helium The production of helium from a preparation of polonium has been observed by Rutherford and Boltwood (Manchester Lit and Phil Society November 30th 1909) and also by Mme Curie and Debierne in their present experiments Boltwood several years ago suggested that the end product of the radium series was lead and has collected strong evidence in support of this view by comparing the amount of helium and lead in old radio-active minerals Since polonium is the last of the active products observed in the radium series it is to be expected that polonium should be transformed into helium and lead one atom of polonium producing one atom of helium and one atom of lead This point of view receives additional weight from consideration of the atomic weight to be expected for the end product of radium Since in the uranium radium series seven α particles each of which is an atom of helium of atomic weight four are successively expelled before radium F is reached the atomic weight of polonium should be $7 \times 4 = 28$ units less than uranium (atomic weight 238 5) This gives an atomic weight of polonium of 210 5 and after the loss of an α particle a final product of atomic weight 206 5—a value very close to the atomic weight of lead

It is a matter of very great interest and importance to settle definitely whether polonium changes into lead The evidence as a whole has long been in favor of that supposition The outlook is very promising that the experiments of Mme Curie and Debierne will settle this question conclusively No doubt an interval must elapse to allow the polonium to decay before the final examination of the residual substance can be made —*Nature*

In a report by the French Consul General at Rotterdam it is stated that 75 vessels of large and medium dimensions aggregating 72 980 tons were built in Dutch yards last year against 76 vessels of 64 806 tons in the year 1908 The average measurement of the vessels built last year was 973 tons whereas in 1908 it was only 850 tons River boats and small seagoing craft were also constructed to the number of 799 and aggregating 150 753 tons the small vessels built in 1908 totaling 683 boats and 112 873 tons A good number of vessels were built for foreign account last year namely—for Germany 60 760 tons for Belgium 9 382 tons for Great Britain 4 2 3 tons for Argentina 3 110 tons for Brazil 1 010 tons other items making up a total altogether on foreign account of 97 900 tons

The World's Greatest Ship—The "Olympic"—a 60,000-ton Vessel



The new White Star liner "Olympic," which was launched from the famous yard of Harland & Wolff at Belfast in October last is far and away the largest vessel ever built, her gross tonnage being half as much again (82 500 tons) as that of the "Mauretania" or the "Lusitania," which until now have held the record for size. Her dimensions are: Length, 882½ feet; beam, 92½ feet; depth (from keel to main deck rail), 62 feet, and her tonnage displacement is 60 000. Her huge hull, divided into thirty water tight compartments, contains nine steel decks, and provides accommodation for 2 500 passengers, besides a crew of 860. She is a triple screw boat and her engines of 45 000 horse power will propel her at a speed of 21 knots. In equipment also she will surpass anything afloat as can be seen from this diagrammatic picture of her interior. The "Titanic," her sister ship, will be launched early this year. Each vessel, when completed, will have cost $7 200 000. —From the Graphic.

THE WORLD'S GREATEST SHIP

The launching of the White Star liner "Olympic" at Belfast on October 20th marked a new advance in naval architecture. Not only is the "Olympic" the largest vessel that has ever been built, but her propelling machinery is of a type that has never been installed on a vessel of such dimensions. After the success of combined turbine and reciprocating machinery in the "Laurentic," it was decided to equip the new steamer with both types of engines and with triple screws.

The "Olympic" outwardly resembles the "Mauretania" of the Cunard Line. She has four elliptical funnels, each 28 feet in diameter. Her length is 888½ feet, her breadth over all 92½ feet, her breadth over boat deck 9? feet, her height from the bottom of her keel to top of her captain's house 10? ½ feet and to the top of the funnels 17? feet; her freeboard is somewhat greater than the "Mauretania's," being about ? feet at the top ? feet to the level of the main deck, ? feet to the boat deck amidships and 42 feet at the stern. She may be distinguished from other four-funnel ships on the high seas by a single pole mast forward of the bridge. The "Olympic" has a maximum draft of 3? ½ feet, on which she displaces about 60 000 tons, as against a displacement of 4? 000 on the same draft for the "Mauretania."

Despite her size, her engines will develop 45 000 horse power, sufficient to maintain the minimum speed of twenty-one knots for which she has been designed. The combined reciprocating and turbine engines are so planned that two reciprocating engines will drive the wing propellers, the exhaust passing into a low pressure turbine driving the center propeller.

The launching weight of the "Olympic," about 27 000 tons, was the heaviest weight ever transferred from land to water, and this operation, always a matter of anxiety to those in charge, was naturally, in the case of so huge a vessel, an undertaking of unusual importance. The method of launching was very simple. The vessel was held on the ways by hydraulic triggers, which were released by the mere opening of a valve, in order that the vast structure might glide into the water.

Some idea of the enormity of the "Olympic" may be obtained when we consider the size and quantity of some of the parts that entered into her construction. Her rudder alone weighs 100 tons, and the weight of the castings comprising the stern frame, rudder and brackets amounts to ?80 tons, or ?0 tons more than those of any other steamer. They were manufactured at Darlington, and special arrangements had to be made for their conveyance to Hartlepool, whence they were shipped to Belfast. The largest beam weighs four tons and measures 92 feet; the longest steel plates are 36 feet. There are 2 500 000 rivets in the ship. Each engine crank shaft weighs 118 tons, each bedplate 19? tons, each column 21 tons, and the heaviest cylinder with its liner 50 tons; the wing propeller 38 tons. The weight of the casting for the turbine cylinder is 167 tons, and of one of the solid bronze propellers 2? tons. The anchors are 19 feet in length and over 1? tons in weight, and each link of their chains weighs several hundredweight. Twelve horses were required to drag one of the anchors to the Naval Exposition at Olympia.

The equipment and furnishings of the vessel have likewise driven home the gigantic size of her hull. Besides the usual dining rooms, lounges, saloons, drawing and smoking rooms, restaurants and verandas and cafés, all beautifully decorated, the "Olympia" will be provided with a complete and well-equipped Turkish bath, a spacious swimming bath, a full-sized squash and racquet court, with a gallery for the use of spectators of the game, electrical bath establishments, sun parlors, sport decks, palm courts, lifts, gymnasiums, etc. These accommodations are provided for 2 500 passengers. The crew will number 860.

Since the advent of the "Great Eastern" in 1858 no vessel except the "Mauretania" and "Lusitania" has created such a vast amount of comment as the "Olympic," not only on account of her enormous size, but also because she represents a new type in naval architecture. In our issue of June 19th, 1909, we published an article on the "Development of the Transatlantic Steamship," in which we traced the evolution of the modern liner from the old "Britannia," which was the first vessel that ever crossed the Atlantic on a regular schedule, to the present day "Olympic." We pointed out at the time that between the "Britannia," with her length of 215 feet and her speed of 8.5 knots, and the "Olympic," with her enormous length of nearly 900 feet and her minimum speed of 21 knots, the changes in construction and in propelling machinery have been remarkable. The two decades that followed the advent of the "Britannia" saw the advent of the "Asia" in 1850, a vessel with a length of 275 feet and a speed of 12.5 knots, and the "Persia," an iron steamship built in 1855, with a length of 385 feet and a speed of 13.8 knots. Then came the "Great Eastern," Brunel's naval masterpiece, a ship so far in advance of her time that she proved a commercial failure, but nevertheless a harbinger of the development which has given us the "Olympic." The "Great Eastern," with a length of 692 feet and a displacement of 28 000 tons, was not exceeded until the "Oceanic" made her appearance in 1899 with a length of 705 feet, a maximum displacement of 32 500 tons, and a speed of 20.7 knots.

The "Great Eastern" marked the transition from the paddle to the screw, for she was equipped with both. The "China," built in 1862, a ship of 3?7 feet in length, with a speed of 14 knots, was propelled by a single screw only. After that the screw propeller completely displaced the paddle wheel. Up to the time of the "City of Paris" and the "City of New York," practically all of the vessels were driven by single screws, a method of propulsion which reached its highest development in the "Umbria" and "Etruria," 525 feet in length and 19.5 knots of speed, with engines of 14 500 horse power. With the "City of Paris" and the "City of New York" began a new period of twin-screw ships driven by triple-expansion engines. When they went into service in 1889, they were by far the finest ships afloat, as well as the largest. They were 560 feet in length, and had a displacement of 16 000 tons.

The "City of Paris" and the "City of New York" were steady and very much along the same lines. The "Lucania," the "Kaiser Wilhelm der Grosse," the "Deutschland," etc., were built in more or less rapid succession, and exceeded their predecessors in size and in speed.

With the building of the "Lusitania" and the "Mauretania," turbine engines permanently entered the field of transatlantic navigation, although the two Cunarders were not by any means the first vessels in which the turbine was installed. In the "Mauretania" and "Lusitania," a speed of from 2? to 26 knots is maintained steadily, but at a cost which might well give less wealthy owners pause. The White Star Line has made no effort to compete with other companies in building ships which will hold transatlantic records for speed. The "Olympic," like her predecessors the "Celtic," "Oceanic" and "Baltic," is a comfortable ship of moderate speed, as speeds go nowadays. In the combination of reciprocating engines and turbines she represents the entrance of a new type whose performances will be watched with not a little interest.

The launching and other exterior views of the "Olympic" were illustrated in the SCIENTIFIC AMERICAN, November 19th, 1910. The present picture is taken from the *London Graphic* and it gives a sectional representation of her interior.

The Structure of Metals

By Dr. Alfred Gradenwitz

One of the most difficult tasks incumbent on the managers of machine shops is the examination of the mechanical and electrical properties of raw materials and the utilization of the results thus obtained for their continued improvement.

In the electrical industry this task, because of the peculiar conditions of the case, becomes especially complicated. In fact, the mechanical properties (hardness, ductility, mechanical strength, etc.) being anything but parallel to the electrical properties (insulation, conductivity), two opposite tendencies have to be accounted for. This industry therefore is especially interested in availing itself of the most perfect processes of chemical and of mechanical analysis.

Whereas the chemical composition of a given material can always be ascertained by means of a more or less complicated analysis, the thermal processes (melting and annealing) and the mechanical operations (rolling, compression, drawing, etc.) undergone by the material cannot be checked by the old methods with all the accuracy and safety required. The metallographic methods recently suggested are therefore specially useful in this case.

The Cable Works of the A. E. G. of Berlin has been among the first to adopt this method. The following examples, two of which are illustrated herewith by microphotographs for which we are indebted to the courtesy of the directors of the works, will give a striking idea of the many advantages afforded by a microscopic examination of polished cross-sections.

The first example is a microphotographic picture representing a brand of cast copper as obtained from wire refuse in the refining furnace. The copper (Cu) having absorbed in melting large amounts of oxygen (O), has united with this element in the shape of red oxide of copper (Cu_2O) incorporated with the copper under the shape of a fine powder up to a certain density corresponding to saturation. By an examination of the microscopic cross-section, the crystals of pure copper (1) are seen suspended in a saturated solution (2) of copper-red oxide of copper.

In the second example, Fig. 1 represents a microphotographic picture of cast copper in which the percentage of red oxide has been increased by intense superheating. Wherever the limit of saturation was exceeded, the red oxide has separated from the solution as well-defined crystal. The following three components of the metal structure are therefore observed in the microscope: Pure copper (1), *copper-red oxide* solution (2), pure red oxide of copper (3).

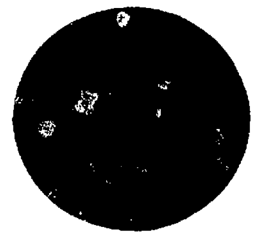


FIG. 1.—A MICROPHOTOGRAPHIC PICTURE OF CAST COPPER SUPERHEATED INTENSELY
Magnified 100 times

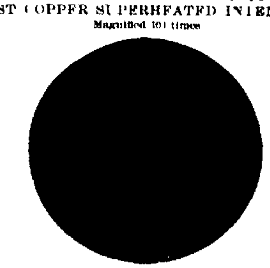


FIG. 2.—STRUCTURE OF SAME SPECIMEN WHEN NON-MAGNETIC

In Fig. 2 is shown the microphotographic picture of a roughly purified cast copper, where the oxygen has been accumulated with a view to burn any metallic and non-metallic impurities, as well as to prepare a reduction as violent as possible of the oxygen, forcing any foreign substances burnt or otherwise to the surface of the bath by a purely mechanical process. As soon as this reduction has been affected the picture (as seen from Fig. 2) only comprises some thin threads of red oxide (2) and copper crystals (1).

Another example finally represents a perfectly refined cast copper. As the red oxide even in slight quantities is detrimental to the mechanical and electrical properties of copper, the oxygen having once done its duty should be driven out completely. The cast copper therefore is submitted once more to intense heating and to reduction, after which even the most minute metallographic observation will no longer ascertain any traces of oxide. Reduction is effected by the immersion of a birch trunk, the components of which (carbon and hydrogen) possess so strong an affinity for oxygen that this element, suddenly leaving the copper in great amounts, combines with the reductive elements, while the melt undergoes a violent seething.

Similar sets of metallographic pictures are prepared at the Cable Works of the A. E. G. for any operation of some importance, three chemists being intrusted with the checking of materials by comparing these pictures with those of typical standard.

After having enriched to a surprising extent our knowledge of living organisms, the microscope thus promises to render an equally efficient assistance to the engineer engaged in industrial pursuits.

The City Water Sterilizing Process Used at Marseilles

By the Paris Correspondent of the SCIENTIFIC AMERICAN

THE fact that city water can be sterilized on a large scale by the use of ultra-violet rays has been well brought out in a series of tests which were made at Marseilles not long since. Owing to the knowledge that the Durance River contains a large amount of bacteria, the municipality felt the need of providing a suitable method for sterilizing the water and one which should allow of a large delivery at the same time. The results of the tests seem to show that the ultra-violet ray method is by far the best for sterilizing and is at the same time easy to carry out with a rapid delivery and takes but a small amount of current, hence the cost is low. We wish to describe the new apparatus for city water use which is designed by Messrs. Henri Helbronner and de Recklinghausen, and it is gratifying to observe that the experiments carried out by V. Henri at the Paris University are now taking a practical shape. There seems to be a great future in store for the new method, seeing that it has none of the drawbacks which are found with the other processes when it comes to using it on a large scale.

In the sand filtering method, for instance, the filters occupy a large surface of the plant, and when not properly operated the results are very imperfect. Besides, the first cost of installing the filtering plant is high. Chemical products added to the water for sterilizing have the disadvantage of giving a bad taste to the water, and the method is not much favored for that reason. One of the best methods for municipal plants has been the ozone process, and it has been used in some large cities. However it gives a certain taste to the water which disappears but slowly, and on the other hand there must be great care taken in the ozone production in order to avoid forming any nitrogenous products which would vitiate the water. Hence the process is somewhat difficult to carry out, or at least needs great care and attention.

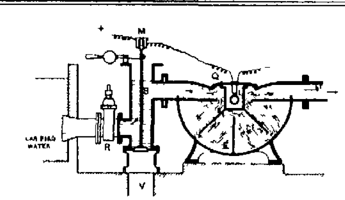


FIG. 2.—SECTIONAL VIEW OF APPARATUS FOR STERILIZING CITY WATER

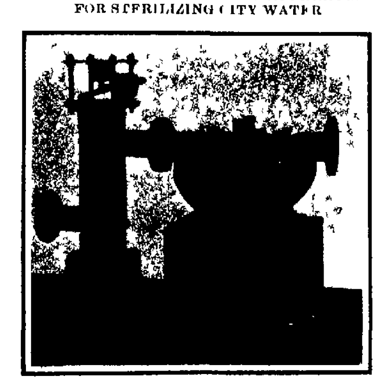


FIG. 1.—APPARATUS USED FOR STERILIZING CITY WATER BY EMPLOYING ULTRA-VIOLET RAYS

In order to find the best solution of the problem the municipal council of Marseilles organized a concourse of sterilizing apparatus. Such a plant was required to deliver 200 cubic meters (261.5 cubic yards) of water per 24 hours and was to be run continuously for one month. The inspection committee included some of the leading specialists in hygiene, mining and civil engineers, and professors of universities. The results of the tests showed that the ultra-violet ray process was undoubtedly the best for municipal use, as it has none of the defects which we mentioned above. It uses a small amount of current, and this has now been lowered in the new apparatus. Neither taste nor smell is given to the water, and the sterilizing is very effective. At the same time the process is easy to carry out and the apparatus needs but little attention. The first cost of the plant is low, and it occupies but a small space.

The ultra-violet ray apparatus was used in connection with a Puech-Chabal filter in order to act upon clear water, and this was necessary from the fact that the Durance water is very heavily charged with impurities which render it turbid. After leaving the filter it passes at a continuous rate through the ultra-violet ray apparatus.

Fig. 1 of our engravings shows the appearance of the Marseilles apparatus and Fig. 2 the sectional view. In the former apparatus the lamps were placed above the surface of the water upon floats so that all of the radiation from the lamp could not be used, and in fact there was only one-third of the rays actually employed for the sterilizing. The authors sought for a means of utilizing a greater proportion

of the rays without changing the manner of working the arc It is recognized that the working of the lamp depends essentially upon the temperature of the electrodes and the luminous tube so that if we cool the lamp too much we will not obtain the same yield in ultra violet rays as before and to reach the same yield the current must be considerably increased For instance if we immerse the quartz lamp in the water itself according to Messrs Courmont and Nogier s method we are obliged to double the current in order to obtain the same yield as in air

A great improvement is obtained by the present apparatus in this respect as it allows of utilizing more than three-quarters of the rays given by the lamp and here the lamp burns in air at its best conditions of working and we thus avoid immersing it in the water The lamp is placed in a rectangular case whose three sides lying parallel to the lamp tube are formed of quartz plate The tight box Q containing the lamp L is placed in a semi-circular apparatus having five partitions in the inside The water is taken from a tank of filtered water and passes through a gate valve and a cylinder chamber S then entering the main tank E It follows around the path which the arrows indicate and in this way it is exposed for some time to the action of the ultra-violet rays, so that we have a powerful sterilizing effect. It is found best in practice to use an automatic valve at the water inlet and it operates in the chamber S A valve in the lower part of the chamber is normally closed and is held up in this position by an electromagnet M which attracts an armature mounted on the end of the valve rod A counterweight is used to give the proper adjustment of the weight. The electromagnet is connected in series with the lamp so that when current passes in the lamp circuit the magnet acts and the valve is held closed. Should the current fail or the lamp break the magnet allows the valve to drop and the water now passes directly out of the apparatus by V into the sewer or elsewhere and no water will be delivered into the sterilizing chamber Thus there is no danger of having unsterilized water flowing through the apparatus in case the current should fail During the tests which were made at Marseilles, the authors used a quartz lamp of the Westinghouse-Cooper Hewitt type, with a current of 22 volts and 3 amperes, and the apparatus was run from August 19th until the end of September, working day and night without stopping. It gave an output of 60 cubic meters (78 5 cubic yards) per 24 hours or 32¾ cubic yards per hour During that time there were made eighteen bacteriologic tests of the incoming and outgoing water Before entering the apparatus the (impure) water contained 30 to 300 germs per cubic centimeter (0 061 cubic inch) and 50 to 1 000 coli bacillus per liter (1 057 quarts) After sterilizing we have on the average one germ per cubic centimeter and no coli bacillus in any case. The tests show therefore a run of six weeks, which gives a continuous sterilization of filtered water with a mean output of 25 cubic meters (32 cubic yards) per hour using current at the rate of 660 watt-hours This gives the lowest value which has yet been obtained or 26 watt hours per cubic meter of water (20 watt hours per cubic yard) so that we have a striking progress with the new apparatus

Drifting of the Sun's Family

A Great Unsolved Astronomical Problem

By Arthur K Bartlett

The part of the heavens toward which it is believed the Sun with its entire family of planets comets satellites and meteor streams including of course our own Earth is moving with great velocity is situated at this season directly overhead about 6 o clock in the evening and at a later hour a little farther toward the northwest This is one of the most interesting and important localities in the firmament to astronomers toward which their attention and observation have been directed for many years past

The greatest fact which modern astronomy has revealed is that our whole solar system is now journeying toward the constellation Lyra in the northern heavens and the greatest of the unsolved problems of astronomy is when where and how this journey began and when where and how it will end This journey is unceasing and unchanging and is believed to be at the rate of twelve miles per second or about 300 000 000 miles in a year The question as to whence we came and whither we are drifting is one of vast importance and is still engaging the attention as it has in the past of the leading astronomers of the world for in connection with it is involved the even greater question regarding the structure extent and boundary of the universe

If we look up to the sky directly overhead just after sunset we shall see a star of the first magnitude known as Vega which is located in the constellation Lyra the Harp and is plainly visible through out most of the evening This star next to Capella is the brightest north of the equator and is famous as being the one which in 12 000 years will occupy the important position of the Pole star and will be known by that name in the future The star shines with a bluish white light and may be easily recognized as it is the most conspicuous of any star visible near the zenith at this season

It is toward this star or rather the group to which it belongs that our Earth and the solar system are believed to be moving and this point in the heavens is known to astronomers as the apex of the Sun s way During the last 120 years many astronomers with ever increasing accuracy have sought to determine the point toward which our Sun the Earth and all the other planets are moving For many years the result of investigations was that our system is traveling toward the constellation Hercules in the northern sky But more recent and careful measures lead to the conclusion that the point is located in the nearby constellation Lyra This point is nearly four degrees south and slightly east of the bright star Vega the variations between final measurements maxima and minima of all who have attacked the great and highly complex problem being as much as seven degrees

Owing to the solar drift in space the orbit of our Earth instead of being an ellipse, is really of a corkscrew shape the axis of the corkscrew being in the direction of the constellation Lyra. The great star-cluster in Hercules containing over 6 000 visible suns is not very far away from that part of the sky which we are approaching and it is possible that our system may form a distant part of one of its encircling wisps of star strewn nebulous matter so that in this case we may eventually be drawn into the gigantic cluster

Most astronomers agree as to the general direction of the Sun s motion, but owing to the motion of the stars themselves there is not yet an exact agreement regarding the amount or direction of this motion In a general way we may say that if an observer looks up to the heavens a little southwest of the zenith on a clear evening at this season he may correctly imagine our Earth and the great system to which it belongs as moving toward the star he there sees presented to his view This motion has been going on since the creation and will probably continue for unknown ages in the future

It is true as a recent writer has well remarked That since the beginning we with the Sun have been steadily speeding on and on through interstellar space without once meeting or passing a single lonely stars brings home to our realization as no other consideration can the amazing amplitude of cosmic space the completeness of the isolation of each star from all others and the supreme magnificence of the scale of the stellar universe

Quite recently a new and ingenious theory has been advanced by two astronomers who have attempted to prove that the millions of stars composing our immense universe are moving in two parallel streams traveling in contrary directions and situated in opposite regions of the heavens but their novel ideas have not been confirmed and have received little attention from astronomers who regard them at present as nothing more than an interesting speculation which does not admit of a practical demonstration though it is possible that careful and long continued observations in the future may produce evidence in its favor

The direction of our motion is indicated by the fact that the stars in that part of the heavens toward which we are traveling are observed to spread out and get farther apart while those we are leaving in the opposite part of the heavens close up and gradually approach each other, just as in walking through a forest the trees in front of us are seen to open out while those in the rear appear nearer together as we leave them behind But at present it is not known whether we are moving in a straight or curved path and if in the latter it is so great that it cannot be determined Many stars which have a proper motion as it is called appear to be moving in a perfectly straight path through the sky Among them is the faint star known as No 1830 Groombridge which is believed to be rushing through space at the rate of over 200 miles per second—a velocity so great that the combined attraction of all the masses in the universe cannot stop this star in its swift and solitary flight over the firmament It is known to astronomers as the 'Runaway Star but there are some other stars that are believed to be traveling even more rapidly and none of them exhibits any indications of moving in a curved path

It is interesting to remark that the motion of the solar system plays an important part in the shifting panorama of the heavens Not only do the stars move onward but the Sun moving also carries us continually northward so that our point of view is ceaselessly changing and looking out from the flying Earth we are like people on a ship which is passing by a squadron of other ships. Their evolutions cause them to appear in constantly changing relations to one another and at the same time our own motion shifting the line of sight, produces other changes of view, which increase the complexity of the apparent movements. In short, we are reminded of the remarkable resemblance of the universe to the modern conception of an atom in which the restless corpuscles are speeding in all directions so that an infinitesimal being inhabiting one of those corpuscles would see the other corpuscles shaping themselves into constellations that would be as unenduring as are the figures that the poetic imagination traces among the stars

The famous German astronomer Mädler over fifty years ago advanced the theory that our Sun and all the stars—which are also Suns—are moving in a great orbit around the star Alcyone located in the Pleiades a prominent cluster mentioned in the Bible and known as the Seven Sisters six of which are plainly visible to the naked eye and may be seen at this season just above the eastern horizon about 8 o clock in the evening But Mädler adduced no evidence in support of his views which were not generally accepted by astronomers His ingenious theory was exploded many years ago and astronomers do not at present recognize any particular star as the center around which all the other stars revolve though it is possible that such a center exists somewhere in the universe

The theory that the solar system is revolving around a central Sun was first suggested by Thomas Wright of England in 1750 and later Mädler supposed that he had discovered the exact center of this motion but it is not thought by astronomers that sufficient evidence exists to support this belief and all that can be said to be established at present is that the Sun with its great family of revolving worlds is rushing through space toward a point in the constellation Lyra a familiar group of stars located in the northern heavens and which may be seen to good advantage at this season in the early evening —*Popular Astronomy*

Albinism and Heredity

Dr. and Mrs Charles B Davenport of the Laboratory for Experimental Evolution maintained by the Carnegie Institute at Cold Springs Harbor, Long Island have recently published another installment of their studies on human pedigrees from the point of view of heredity This is concerned with the question of albinism in man and some of the conclusions are of general interest.

So far as the evidence goes the children of albinos are always albinos In albino marriages albino children may be expected without regard to the parentage of the albinos themselves For example in one of the cases given the mother was of negro parentage while the father was of Caucasian parentage, but the offspring was without any pigmentation.

The authors think that in every new case of albinism there is a probability of consanguinity among the parents But this seems to be reasoning backward from the fact that out of a number of cases one-third of all the albinos arose from consanguineous marriages The facts appear to agree with the general rule that a recessive character (and albinism is a recessive character in most animals that have been studied) arises only when both parents carry the same defect "and the probability that both carry the same defect is increased when both belong to the same strain"

The proportion of albino offspring in any family accords with the Mendelian expectation, in the long run, as in other mammals. When one parent is albinic

and albinic offspring occur at all there will be one-half albinic and one-half pigmented In these records there were sixteen albinic and fifteen normal children in five families.

Comparison of the hair coloration in the parentage of albinos with that in the normal population shows a great preponderance of red and auburn hair among the former while dark browns and blacks occur less frequently—65 per cent as compared with 81 5 per cent in the general population Albinos frequently have a blue iris this fact does not appear to be correlated with the preponderance of blue eyes in the parentage of albinos

As to the causes of albinism the authors conclude that it results from the fortuitous union of two germ cells lacking a pigment factor The meaning of this is not very clear It may mean either that the parents bear such germ cells as part of their inheritance—in which case it is but another way of saying that albinism is congenital and is inherited according to definite mathematically calculable probabilities or it may mean that germ cells lacking the pigment factor are present in all individuals in small numbers and their union is a relatively rare event The facts brought out in the study point to the first as being the probable meaning of the authors but in that case we are still in the dark as to the cause of albinism

Paris as a Seaport

A Proposed Canal between Paris and Rouen

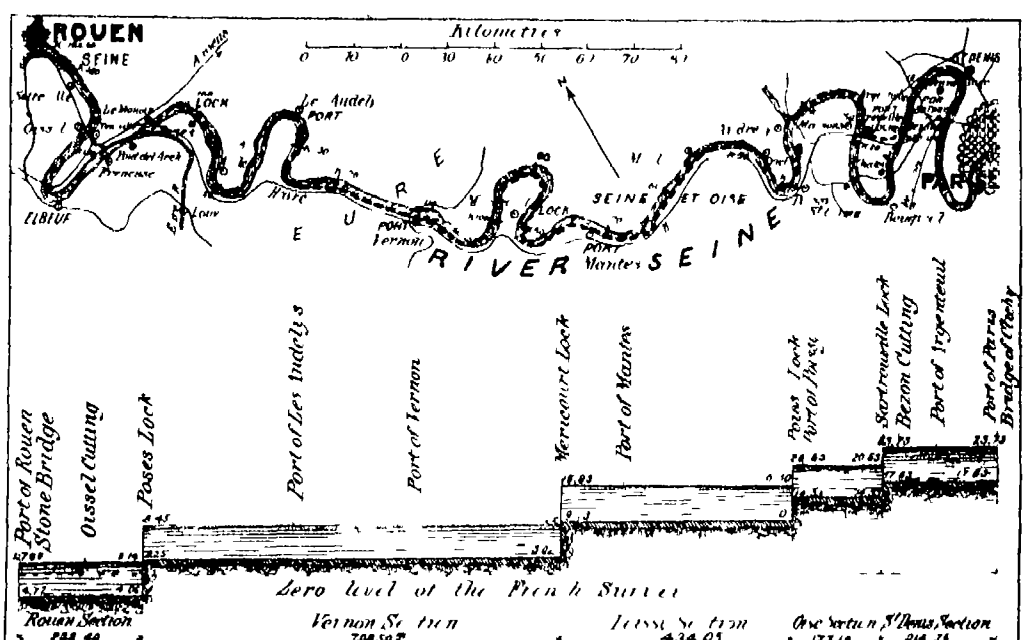
By the Paris Correspondent of the Scientific American

A PROJECT has recently been made to establish a navigable connection between Paris and the English Channel so as to convert the French capital into a seaport and allow vessels up to 3 000 tons draft to unload freight at the docks The cost of this undertaking is estimated at thirty to fifty million dollars Aside from the other obvious advantages which would be derived from such a plan one circumstance which commends it particularly is the fact that it would preclude all possibility of any repetition in the future of such disasters as were recently caused by the flooding of the Seine The idea of turning Paris into a seaport is not by any means new but has of late years been suggested repeatedly One of its principal advocates was M Bouquet de la Grye who in 1886 presented a project to the government suggesting a deepening of the bed of the Seine between Paris and Rouen From this point on to the mouth of the Seine at the English Channel (a distance of 76 miles) the natural depth of the river is sufficient and at the present time vessels travel up the Seine as far as Rouen where the minimum depth is 16 to 18 feet the port accommodating vessels ranging up to 3 000 tons From Rouen to Paris the Seine channel has a depth of only 10 feet It is proposed to increase this to 21 feet so as to enable vessels to travel all the way to Paris by water The channel would follow all the windings of the Seine except for two short cuts where a separate canal would be built so as to avoid crossing the Paris Havre Railroad Our illustration for which we are indebted to *l'Illustration* shows this and other features to be referred to below The total distance of the journey is about 130 miles and would be covered in about eighteen hours with the usual tugboats As regards the width of the river it is 115 feet at water level in straight portions and 150 feet at curves with a radius of less than 5 000 feet By the way of comparison it may be mentioned that the Manchester canal has a maximum width of 119 feet while the Suez canal is 122 feet broad The project in its present form provides for five levels with locks while the section from Rouen to the Channel would be open and would take up the variations of the tide

The plans include twenty four drawbridges The port at Paris would be located at the suburbs of St Ouen The total cost of the engineering work is estimated at thirty million dollars and the total capital invested at fifty millions

This project of establishing a seaport at Paris has now once more come to the foreground and is being discussed in the daily newspapers in Parliamentary circles and also by the municipal council of Paris who are in favor of its adoption Just at this time with the memory of the Seine inundation freshly in people's minds and with the pressing problem of providing measures to guard against such accidents in the future the soil is very favorable for the project to strike root It would save the community the dead cost which would be involved in carrying out any of the other plans that have been proposed for coping with the situation The cost of the project outlined above might quite probably be borne by a private enterprise The municipal council is now however disposed to have the city take the matter into their own hands and has pronounced its sentiment to this effect by a unanimous vote That the city is quite capable of handling such enterprises successfully is evidenced by the very extensive network of the Paris subway, which when completed will have an aggregate length of no less than seventy miles In any case the enterprise would pay for itself A tax of $0 40 to $0 60 per ton gage for sea-going vessels would be collected and also pilot taxes and other rates for river boats, thus yielding a constant return Soon after the enterprise was placed on a working basis, the receipts would, no doubt, pay 5 per cent interest on the capital and yield a handsome surplus. This is a very conservative estimate and takes no account of the great increase in traffic which would no doubt develop in the future. It is estimated, that having regard only to traffic which can be counted on with practical certainty this would amount in the second year of operation to about ten million tons

The project is attracting attention in countries outside of France especially those which now possess large seaports such as Antwerp and Hamburg and should it be carried out Paris will enter into competition with these ports as well as with London so that the entire European traffic will be affected Antwerp would lose a part of its shipping which now comes from Paris and Eastern France Alsace Switzerland and Bavaria It is interesting to note



Plan View and Profile Section of the Proposed Canal from Rouen to Paris

that towards the end of the century recently completed London lost something of its supremacy as a European freight seaport Gradually we have seen Germany Belgium and Holland assuming an independent position of prominence Since 1893 the traffic of Hamburg has increased 80 per cent Antwerp has about the same showing and Rotterdam has gone up by no less than 160 per cent During this period the London traffic increased by only 30 per cent France however has been far behind as regards the merchant marine and could not compete with other leading countries At the present time France sends on an average twenty five million dollars worth of freight to London to have it reshipped from there to different points of the globe Should the new project be carried out this state of affairs will be entirely changed and Paris will rank among the principal seaports of Europe It will receive within its harbor vessels arriving from distant countries A boat which has traveled some ten or thirteen thousand miles coming from Australia South America or China will not hesitate to go a little extra distance and land at Paris instead of London if the conditions of the trade render it desirable

The Independence Bell of Mexico

IN connection with the recent centennial celebration of the independence of Mexico it may not be so generally known that each year on the recurrence of the anniversary which is always joyfully celebrated an interesting scene is to be witnessed in the Mexican capital On the evening of this day President Diaz with his ministers and state officials assemble in the great ambassadors hall in the palace In the great Zocalo before the National Palace is waiting a crowd of many thousands high and low poor and rich In the Biography of Porfirio Diaz compiled by Tweedie the scene as witnessed annually is thus described "It is historic ground on which the crowded masses stand for here many many years ago arose the great Aztec temple Under their feet deeply buried lie altars and urns sacrificial stones and axioms and many heads of the great snake—much has already been brought to light but the earth still covers and envelops a great deal

And now a new race celebrates on this sacred ground the memorial day of their regained liberty The national palace is gaily decorated and the city hall opposite is brilliant in bright illumination In the dark wonderfully beautiful sky the moon shines silvery with a soft radiance surrounded by innumerable glittering stars Below however the bright electric lights gleam on the white shirts and the red hats of the men and the multi-colored rebozos of the women all gaze earnestly at the great brightly lighted clock the hands of which approach the hour of eleven But a minute of the time is lacking when the balcony doors of the palace are thrown wide open and from the apartment within the President makes his appearance clad in festal garb with the broad sash of the President's office across his breast and in one hand the flag of Mexico Behind him are ranged the ministers In the pent up silence of the waiting throng he raises his hand to the cord leading up to the great bell hanging above him and rings on it eleven strokes Deep and full the resounding notes of the great bell tell of the nation's independence as it did on a previous occasion one hundred years ago when it rang from the Dolores church It was brought from there to Mexico in 1896 When the last stroke has resounded the President proclaims in ringing far reaching tones Live the independence and live Mexico The silence is broken the solemn moment is passed and a many thousand throated cheer rings over the great plaza in the stillness of the night

The fact has been established that the bubonic plague is primarily a rat disease and that it is transmitted to human beings chiefly by means of fleas which infest rats Permanent freedom from the rat pest can be secured only by preventive measures The means of ingress to a building must be stopped and the animals deprived of food when they can be easily trapped The bacteria preparations on the market for killing rats may be depended on to kill the rats which eat the prepared bait but they do not set up an epidemic as has often been claimed They are inferior to the poisons and their price is practically prohibitive when used on a large scale

The Destruction of Weeds by Chemical Means—I

An Important Agricultural Problem

By Harold C Long B Sc, Author of "Common Weeds of the Farm and Garden"

During the past twenty years an increasing amount of attention has been devoted to the economic side of insect and fungous pests with a view to their extermination and The Destructive Insects and Pests Act of 1907 gives the Board of Agriculture and Fisheries power to deal with the whole question and to carry out compulsory preventive and remedial measures in the case of such species as they consider of sufficient importance to schedule in their orders[1] The attention of scientific workers has for many years been turned to the necessity of acquiring a thorough knowledge of the life histories of all the worst insect and fungous pests of farm garden and orchard and a vast fund of information has been acquired by a systematic study of individual species Such study in conjunction with experimental work has been necessary in order to eradicate the particular post concerned and here also much has been accomplished even though it be said that much remains to be done

Fig 1—Charlock (*Sinapis arvensis* L) × 2/3 This Weed is Readily Destroyed by Spraying with a Solution of Copper Sulphate or Iron Sulphate

What however is the position in regard to the prevention and eradication of the common weeds of the farm and the garden which annually cause so much loss to the grower of crops? It may be said that a good deal has been done to enable the unbotanical worker to identify species and a few practical botanists and agriculturists have offered sound advice as to the mechanical destruction of weeds Yet the information available is still quite inadequate and while some of the highly farmed lands are more or less weedless the majority of farmers meet with two or three species of weeds which they experience extreme difficulty in combating The question of weed eradication is one of real difficulty and when we bear in mind the fact that many serious insect and fungous pests are supported and distributed by weeds it assumes an importance which the entomologist and mycologist would do well to recollect Prof Somerville has written[2] Using the term in its widest sense *good cultivation* will be found to be the best protection that the farmer or gardener can offer his crops against insects and good cultivation includes the destruction of weeds In many countries the importance of destroying weeds has long been officially recognized and acts have been passed requiring the destruction of specified weeds In Great Britain however the only laws of the kind refer to Ireland and the Isle of Man

Fig 2 Persicaria or Redshank (*Polygonum Persicaria* L) × ½ This is a Pest of Good Arable Land and Gardens It Has Been Quite Destroyed by a 4 Per Cent Solution of Copper Sulphate (100 Gallons Per Acre)

THE PREVALENCE OF WEEDS

We have said that some highly farmed lands are more or less weedless but it is undoubtedly true that most farms are far more weedy than they either ought to be or need be In the third week of August 1909 we found in an area of perhaps a hundred square yards of a wheat field no less than twenty nine species of weeds the majority of which were among the most troublesome of all (including the species illustrated in Figs 1 5 6 and 8) Similar cases could be quoted We consulted twenty nine experts in different parts of the country from the North of Scotland to the South of England and species of couch or twitch were included thirty two times among the six worst weeds of arable land charlock and runch twenty-eight times docks sixteen times thistles sixteen times coltsfoot thirteen times and so on As regards grass land thistles were regarded as the worst in twenty two cases buttercups sixteen Yorkshire fog (*Holcus lanatus* and *H mollis*) nine docks eight and so forth These figures show that the species named are not only widely distributed but in the cases mentioned are real pests of farmers In good garden soil well cultivated for three years we found one thousand and fifty seedlings in a square yard on May 17th 1909 and of these seedlings six hundred and fifty four were those of creeping buttercup one hundred and seven *Poa annua* and sixty were a species of dock Many seedlings were subsequently destroyed on the same square yard Plenty of other evidence as to the prevalence of weeds could be adduced

Fig 3—Petty Spurge (*Euphorbia Peplus*) Natural Size This Weed is Very Common and Plentiful in Some Districts It Appears to be Protected From Spray Fluids by a Glaucous Bloom on the Leaves

THE HARM DONE BY WEEDS

Many pages could be written dealing with the losses caused by weeds but the matter can only be briefly mentioned here It may be stated however that weeds take up the space which should be occupied by the cultivated plant weeds rob the crop of food and moisture and of air light and heat, they hinder thorough cultivation harbor injurious insects and fungi are parasitic on crops may be poisonous stop up drains, and their seeds may very seriously reduce the value of those of agricultural plants which hence require very thorough cleaning, involving considerable expense In short, the cash losses due to weeds are very serious The following examples will suffice

(1) The nitrogen in the dry matter of Persicaria (*Polygonum Persicaria*) was found to equal nearly 20 per cent of albuminoids[3]

(2) A twenty five bushel crop of wheat was found at the Agricultural Experiment Station of Cornell University to transpire (during growth) five hundred tons of water Weeds probably transpire to a somewhat similar extent

Fig 4—Corn Cockle (*Agrostemma Githago* L) × 2/3 Not Only a Weed in the Usual Sense but it is Poisonous in a Degree Spraying is Partly Effective and Generally Prevents Seeding (See Text)

(3) Charlock (*Sinapis arvensis* L) and other cruciferæ are hosts for the Turnip Flea Beetle or Fly (*Phyllotreta nemorum*) the Turnip Gall Weevil (*Ceutorhynchus sulcicollis*) the Diamond Back Moth (*Plutella maculipennis*) Finger and toe Turnips (*Plasmodiophora brassicæ* Wor) *Peronospora parasitica* De Bary and other pests

(4) Wollny has placed the annual loss of crops due to weeds in Bavaria at an average of 30 per cent[4] Korsmo found the percentage loss in money value on a weedy compared with a clean plot of barley to be 46 per cent and in the case of potatoes 49 per cent.[5] Experimental plots at University College Farm Reading showed that with two hoeings only after "singling mangolds yielded over thirty-seven tons per acre but when unweeded the yield was only slightly over sixteen tons per acre

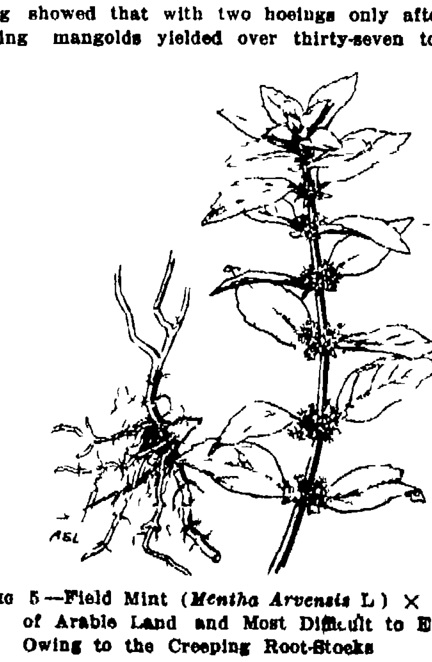


Fig 5—Field Mint (*Mentha Arvensis* L) × ½ Pest of Arable Land and Most Difficult to Eradicate Owing to the Creeping Root-Stocks

(5) If the real value of agricultural seeds, owing to impurity and low germinating power be only 76 per cent. then the (initial) loss in cash would be 24s ($5 83) in £5 ($24 25) if bought at the rate for best seed

THE DISTRIBUTION OF WEEDS.

Regarding the manner in which weeds are distrib-

* Knowledge

[1] The Destructive Insects and Pests Order of 1910 schedules sixteen destructive insects and pests whose presence on any premises must be notified to the Local Authority or to the Board of Agriculture and Fisheries.

[2] Farm and Garden Insects, p. 20.

[3] Stutzer and Seidler Fühling's Landw. Zeitung, June 15th, 1908, p. 420.

[4] Fr Meier-Bode, Die Bekämpfung der Acker-Unkräuter.

[5] Tidsskr. Norske Landbr 10 (1903).

weeds it may be said shortly that the seeds are scattered in the same general way as with other wild plants—by transportation through the agency of man, railways, shipping, and so on, by rivers and floods, by birds and wild animals, by wind (owing to extreme lightness of the seeds or to their bearing flight organs), and by seeds adhering to animals (or man) by means of hooks, and so forth In other cases broken portions of the rootstock may be transported and give rise to new centers of infestation

CO-OPERATIVE DESTRUCTION OF WEEDS

We may now consider the means at the disposal of the farmer for the purpose of destroying weeds and all may be covered by co-operation which should be devoted to (1) The supply of pure seeds free from the seeds of weeds, (2) the mechanical destruction of individual species which may prevail in a given district by means of the ordinary routine methods practised on the farm as well as by special measures, and (3) the destruction of weeds by spraying

If farms are to be kept free from weeds and farmers are to be prevented from causing infestation of a neighbor's farm by neglect of their own it must be by compulsory eradication or by co-operation—*farmers must work together*

Regarding (1) it is clear that a combination among say fifty farmers in a district will enable them to purchase large lots of high class seeds at a fair price under guarantee and to have them sampled and tested A pure seed supply will thus be insured

In relation to (2) it may be suggested that mechanical destruction should include co operative eradication of docks and thistles by the use of docking irons spuds thistle cutters regular cutting of many weeds by hand and by power machines cutting of weeds on

Fig 6—Knot Weed (*Polygonum Aviculare* L) Reduced A Serious Trouble to Farmers Often Occurs in Incredible Quantities on Light Sandy Soils

waste lands and roadsides to prevent the formation and distribution of seed the collection of seed shed at harvest time by the use of box attachments to reapers and binders thorough cleansing of thrashing machines before they go to the next farm co-operative purchase and use of surface weeders like the poppy killer American weeder and so forth A year or so ago Dr Ewart government botanist of Victoria suggested that school children should be offered prizes for collecting certain weeds A police magistrate offered prizes and 12 000 plants of Ragwort (*Senecio Jacoboea*) were brought in during the first four days the number quickly rising to 20 000 plants

(3) The destruction of weeds by spraying is of most interest and is dealt with below

THE DESTRUCTION OF WEEDS BY SPRAYING

It is only in recent years that attempts have been systematically made to destroy weeds by means of chemical substances these having been chiefly applied in the form of simple solutions The method appears to have originated in France, where M Bonnet found, about 1896, that a solution of copper sulphate destroyed charlock (*Sinapis arvensis* L.) without permanently injuring the cereal crop among which it grew Attention was directed to this fact in the press, and a host of experimental trials was soon conducted, the result being that the facts were quickly established, and in 1900 a leaflet on the destruction of charlock by means of spraying with the sulphates of iron and copper was issued by the Board of Agriculture. Forty gallons of a 4 per cent solution of copper sulphate or a 15 per cent solution of iron sulphate may be sprayed over an acre of the crop when the charlock is about three inches high and if the operation be properly performed during suitable weather the weed will be destroyed and the cereal remain practically uninjured

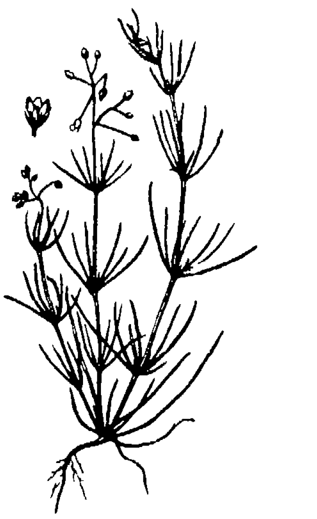


Fig 7—Spurrey (*Spergula Arvensis* L) × 2/3 This Plant is One of the Most Troublesome Weeds on Light Sandy Soils Being an Annual it is Only Necessary to Prevent the Ripening of Seed It Has Been Found That a 5 Per Cent Solution of Copper Sulphate Destroys It

It is believed that the rough broad more or less horizontal leaves of charlock catch and retain the solution while the narrow smooth practically vertical leaves of the cereal throw it off and hence are not damaged In this connection there is room for further investigation and it may be commended to the chemist and botanist alike as a source of interesting research

Since the introduction of spraying for the destruction of charlock a number of experiments has been carried out and many investigators have made trials with a variety of plant poisons the effects of which have been observed when applied to a number of species of plants Though the results are interesting and some information has been obtained they are by no means conclusive but it will be useful to refer here to some of the experiments and their results

In the course of experimental work in spraying charlock (Fig 1) with iron sulphate in 1898 it was found by Prof Somerville that both at the North umberland County Farm Cockle Park and in the grounds of the Durham College of Science (New castle on Tyne) all rough leaved plants such as thistles and to a lesser extent coltsfoot (*Tussilago Farfara* L) were crippled while glaucous plants like species of *Chenopodium* were not affected

It is well known that broad leaved plants are often scorched when nitrate of soda is broadcasted on them It was stated ten years ago that a solution of 15 to 40 per cent of nitrate of soda and sulphate of ammonia sprayed on young charlock plants in the early rough leaf stage caused them to begin to wither in a couple of hours Chloride of potassium is said to have a similar effect on charlock when applied in solution

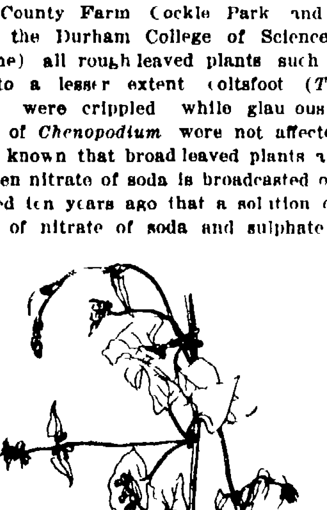


Fig 8—Black Bindweed (*Polygonum Convolvulus* L) × 2/3 A Most Mischievous Annual the Twining Branches of Which May be Several Feet Long and Drag Down Cereal and Other Crops Partly Destroyed by Spraying With Copper and Iron Sulphate Seeding Being Largely Prevented

About seven years ago Mr G F Strawson stated in regard to copper sulphate that It is now admitted that mangolds as well as beans peas tares wheat oats and barley can be sprayed without injury and the charlock among them destroyed and that the spraying does no harm to the young grass seeds clover sainfoin and so on growing in the crop Evidence on this point however is conflicting as we shall see and in Germany V Rümker only last year held that spraying sugar beets with sulphate of iron is hazardous (There may be some difference in sensitiveness between mangolds and sugar beets and also in the methods of spraying) Only this summer Mr Strawson repeats that mangolds have been constantly sprayed during the last seven or eight years and that he has never heard of a single instance where the crop was appreciably injured He also repeats that corn tares sainfoin clover beans (and peas in most cases) can be safely sprayed with pure copper sulphate to eradicate charlock The statement regarding mangolds was confirmed a week later in the same journal by another writer

A good deal of experimental work in spraying has been conducted at the North Dakota Agricultural Experiment Station by Mr H L Bolley and some of his results are interesting His experiments commenced in 1896 with copper sulphate and mercuric bichloride and the results in killing charlock without injury to wheat are described as surprisingly successful Bolley found that the best time to spray is when the crop and weeds are making rapid growth that slow growing weeds are hard to kill and that the more succulent the weeds the more easily are they destroyed Sodium arsenite in preliminary ex

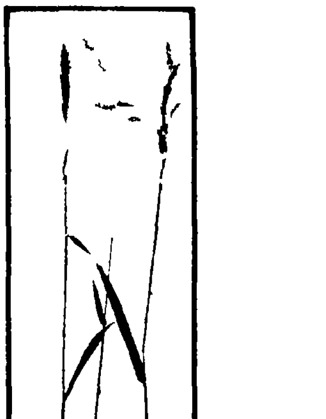


Fig 9—Yorkshire Fog (*Holcus Lanatus* L) A Great Trouble in Many Pastures Very Common and Widely Distributed A Hairy Grass Refused by Stock

periments was usually much more efficient as a weed destroyer than the sulphates of iron and copper it acts quickly destroying the weeds (apparently charlock and king head) even though rain follows within a few hours Referring to the two sulphates Bolley concludes (in Press Bulletin No 27 1907) These substances are recommended here for mustard and king head and will dispose of other annual weeds which they thoroughly wet including Red River weed common rag weed and pepper grass and will much weaken and retard the development of the French weed wild buckwheat black bindweed rose bushes wild docks Canada thistle and many other of the destructive weeds which invade cereal crops In Bulletin No 80 (1908) Bolley shows that at the North Dakota Station they have successfully used in various sorts of weed eradication work common salt sulphate of iron sulphate of copper corrosive sublimate and sodium arsenite but because of its cost and its extremely poisonous character the corrosive sublimate (mercuric bichloride) is not recommended for weed killing while the arsenite must be used with great caution

(To be continued)

Tinning Large Articles of Copper Brass Cast and Wrought Iron (according to Bonsfield)—Pickle the articles in dilute sulphuric acid Then place them for 8 hours with 64 parts of zinc in pieces in a composition heated by steam to 158 deg F and made by dissolving 15 parts of cream of tartar in 3 200 parts of water Neutralize with 2 parts of precipitated chalk and add 7 parts of tin salt dissolved in 320 parts of water

Jour Dept. Agric., Victoria, 1908

Jour d'Agric. Pratique, 1897

As stated below, Mr H. L. Bolley started spraying investigations in the United States in 1896, and says they were perhaps the first experiments of the kind conducted in any country

The Field July 9th, 1896

Fifth Annual Report on the Destruction of Charlock in Corn Crops in 1903

Deut Landw Presse February 6th 1909

Farmer and Stock Breeder June 11th 1910

Press Bulletin No 9 1903

Correspondence.

Solar Power

To the Editor of the SCIENTIFIC AMERICAN

I have read with much interest the articles appearing in the SCIENTIFIC AMERICAN of January 21st 1911, and the SCIENTIFIC AMERICAN SUPPLEMENT for January 21st 1911 Previous to the reading of these articles in the SCIENTIFIC AMERICAN I had read them in one of the London scientific papers

You head the article in the SCIENTIFIC AMERICAN as follows Whereas Fessenden assumes that water can be raised by the sun s rays to its boiling point the highest temperature which is mentioned in scientific literature within our knowledge is 65 deg Cent or 149 deg Fahr

We have in an actual business way anticipated practically everything Prof Fessenden writes about To prove this we are sending you one of our catalogues published some three or four years ago Since the publication of this catalogue we have greatly improved the absorbing qualities of our heater and have greatly simplified the construction

We have spent $75 000 in the commercial exploitation of the sun s rays and have built six different sun motors and have proved them out in an absolutely scientific way Prof R C Carpenter of Cornell University has gone into the matter slightly and admits that what we say is true as far as he can go Mr A S F Ackermann M E of London has tested the steam producing qualities of our sun heater by actual careful tests spreading over three different experiments and he has indorsed the fact that we can get the amount of steam out of the amount of area which we have assumed

You are no doubt right that you have not seen higher temperatures than 149 deg Fahr in scientific literature The fact however remains that we have obtained in this high latitude an apex temperature of 267 deg Fahr and the production of 212 deg atmospheric steam is an easy matter for us on any clear sunshiny day in this high latitude In the tropics where we intend to use the sun engine we will no doubt get greatly higher temperatures than this In this latitude in summer time between 10 o clock in the morning and 3 o clock in the afternoon atmospheric steam (212 deg Fahr) can be produced in paying quantities

The problem of constructing a sufficiently cheap sun heat absorber is not a serious one We accomplished this over three years ago The problem was to find a steam engine which will use the steam (or boiling water) produced by the sun heat absorber in a proper way The assumption that a low pressure turbine will do this is entirely wrong It is true a low pressure turbine will run with the steam generated directly or with the steam caused by the evaporation under a partial vacuum of a 212-deg temperature water

Owing however to the impossibility of getting a turbine to work with proper efficiencies with such widely varying quantities of steam we have given this idea up after trying three different turbines

We were therefore compelled to invent a low pressure reciprocating engine which uses with equal efficiencies (based on the thermal efficiency) the steam produced by the sun s rays at all times of the day from 7 o clock in the morning until 5 o clock in the afternoon in the tropics

We have reason to believe that we are the only ones who have ever actually built practical sun power plants Everything we have thus far heard from has either been fictitious or has been based on a very short and erratic series of operations and many breakdowns

We have unquestionably solved the problem of producing sun power However we have found that in order to produce sun power plants of 25 horse power and over up to 100 000 horse-power—the larger the better—the total cost of construction per brake horse power including everything is $300 This will produce a power plant which gives fuel for absolutely nothing cuts down the labor to less than a quarter and cuts down the wear and tear to less than one tenth of the best modern steam plant

Counting the interest on the investment we find that we can compete with $3 coal in the tropics at this stage of our knowledge We cannot expect to bring sun power at once to an apex We see many ways ahead of cheapening construction and increasing efficiency and have no doubt that another ten years of experience will enable us to compete with $1 coal in the tropics

It must be remembered that a sun power plant which in the tropics can compete with $3 coal (counting in the greater interest due to the greater investment) is at the present moment a very good commercial investment. There is room for a million horse-power in the true tropics where coal is above $5 per ton, and room for easily an equal amount where coal is from $5 to $20 per ton Those are of course, the places where the first sun-power plants will be exploited

Prof Fessenden s idea of storing power by pumping water to a great height in tanks, is correct as far as it goes But we can store a much greater power at greatly less expense by storing up the boiling water in the manner shown in our catalogue.

The sun engines which will be built during the coming five to ten years will be mainly irrigation engines where the quantity of water pumped need not be of necessity steady during the twenty four hours If the sun power plants are used for irrigation the problem becomes much simpler because in the first place the water used for irrigation can be pumped through the condenser and then into the reservoir or on to the land and then the atmospheric steam evolved can be used direct in the peculiar reciprocating engine which we have invented

We have invented a reciprocating engine which has on low pressures far greater economy than any turbine or reciprocating engine Prof Carpenter tested this engine very thoroughly and from his report dated February 24th 1910 I will quote the following

I do not know of any other type of prime mover steam engine or turbine having the same capacity which could have done as well I should certainly have expected 20 to 30 per cent higher steam consumption from any other piston engine and 50 to 60 per cent from any steam turbine of the same capacity

On sending Prof Carpenter s complete report to London for the purpose of securing money the London company sent over here Mr A S E Ackermann B Sc (Eng) A C G I A M I C E M R S I who went over Prof Carpenter s tests and showed an even better steam economy owing to the fact that he ran his engine to higher power by increasing the number of revolutions Mr Ackermann s best result was 26 5 pounds of steam at atmospheric pressure per brake horse power

Remembering that the engine tested was only a 30 horse-power reciprocating engine you will find this economy quite remarkable There are few 800 kilowatt turbines than can equal it and the most of the 800 kilowatt turbines this little 30 horse-power reciprocating engine has beaten When the size of this engine is brought to the 800 kilowatt mark the economies would of course be much greater

To recapitulate we have this much desired sun power idea above the experimental stage and we are going into the construction of actual working engines We are now constructing a 25 horse-power sun plant which will be ready for testing on July 1st of this year here in Tacony It will be run until everything is found correct and then sent to Cairo Egypt and tried there

The reason why we can count on certain results is that this will be the final one of a long series all of which gave good results and every succeeding one of which was better than the previous one The great handicap that the sun power inventor has is that the ordinary business man will not invest money in a scheme of this kind until he has been most convincingly shown The money used heretofore has come from myself and personal friends who have made good dividends from other inventions made by me

There is a great similarity between sun power and aviation You will at once admit that any business man approached several years ago with a view of purchasing stock in a flying machine company would have feared the sanity of the proposer After it has been shown conclusively that it can be done there is now no difficulty in securing all the money which is wanted and very rapid progress in aviation is from now on insured We will have to go through this same course

You have published in your paper a great deal of my work and a number of my inventions for instance the building of the City Hall tower of Philadelphia the wire glass machines the Simplex piling operations the wool-degreasing machines and you did publish my first ether sun engine

Philadelphia Pa FRANK SHUMAN

American and Argentine Dreadnoughts

To the Editor of the SCIENTIFIC AMERICAN

The interesting article in the June issue of the Navy and the reply thereto in the SCIENTIFIC AMERICAN of August 27th concerning the relative merits of the Argentine battleships Rivadavia and Moreno and the American battleships Wyoming" and Arkansas give rise to many interesting comments

Whether the Rivadavia or the 'Wyoming" will prove to be the better vessel cannot be positively decided until the two vessels have been launched and completed Still with the data at hand, one can see that the estimated speed of the 'Rivadavia (22½ knots) is two and a half knots greater than that of the Wyoming This in itself is a heavy handicap on the American vessel and would put her in an inferior class when speed alone becomes the issue.

Turning to the displacement, we find that the Argentine vessel has the advantage by 3,957 tons over the Wyoming's' displacement of 27,243 tons. The coal supply of the 'Rivadavia (4,000 tons) is three-quarters greater than that of the other vessels. This would enable them to keep the sea longer, besides allowing a wider radius of action.

In the event of a naval campaign by a squadron of Rivadavias against a squadron of "Wyomings," the greater radius of action and superior speed of the former might decide the fate of a campaign, and compel the slower vessels to adopt a more cautious plan of attack so as to husband their inferior resources.

Maneuvers in naval warfare are often as decisive as a pitched battle and far less expensive in the matter of blood and treasure The presence of a 'fleet in being has often changed the entire nature of a campaign as in the case of Lord Torrington After the battle of Beachy Head in 1690 that officer's disposition of his fleet no doubt prevented De Tourville, the French admiral from moving troops across the channel into England Again during the Russo-Japanese war Admiral Essen s Vladivostock squadron raided the east coast of Korea and sank several Japanese transports Subsequently these fast vessels moved over to the Pacific coast of Japan and threatened Yokohama. Although these movements did not make Togo release his grip on Port Arthur or compel Oyama to abandon the advance on Liao-Yang Kamimura s Japanese squadron was compelled to remain in the Straits of Tsushima so as to protect the troopships going to Manchuria Kamimura s four armored cruisers would have been a welcome aid to Togo at the battle of August 10th 1904 Had fortune continued to favor Essen and Bezobrazoff they might have accomplished a great deal more and perhaps changed the character of the war

Again in our war with Spain the formation of the Eastern Squadron under Commodore Watson for a descent on the Spanish coast helped to compel the slow Spanish fleet to abandon the voyage to Manila and return to Spain Watson s fast squadron although it never left West Indian waters nevertheless had a powerful influence in bringing the war to a close In this way it can be easily seen that the fast Argentine vessels would possess considerable advantage over their American contemporaries when operating against each other

In the matter of the fire superiority the vessels are equally armed in the main batteries but the arrangement of the turrets gives the Wyoming' a weaker head-on fire than the Rivadavia The former vessel can train only two turrets directly ahead on a line with the keel while the latter can support her two forward turrets fire by the two midship turrets one on each side of the vessel These have an arc of forward fire of ninety degrees In the American vessels the two midship turrets have only an arc of fifty degrees forward fire and they would thus become masked as the line of fire became dead ahead

Turning to the broadsides the two vessels are practically equal while in their stern fire almost the same condition prevails In the latter case four turrets would have a direct fire On the American vessels the line of fire would be on a line with the keel while on the Argentine vessels the stern fire would be as powerful as the forward fire and owing to her *echeloned* turrets amidships the fire superiority would be identical Hence as long as the *echeloned* turrets remained intact the Rivadavia could fight on her own terms while to equal her the Wyoming would have to present her stern fire or else maneuver into a broadside position and rake her opponent

When we come to the matter of armor protection we can simply keep in mind Admiral Farragut s maxim The best protection against an enemy s fire is a well-directed fire of your own Armor while essential, is not absolutely a security against gun fire when we consider that the heaviest shot are capable of penetrating very thick armor

In the event of battle good seamanship together with good tactical management and gunnery would decide the affair although it clearly appears that the Rivadavia would have the advantage at the start.

Brooklyn N Y GERALD ELLIS CRONIN

A handy way to remove a wood screw that has stuck and is so tight that there is danger of twisting off the head is as follows Heat a poker or a piece of round iron red hot, and hold it against the screw head for a little while Wait a few minutes for the screw to cool off when it will be found that the screw can be removed quite easily with the same screw driver that just previously would not perform the work. The explanation is simple. The red hot poker heats the screw the screw expands and makes the hole it is in just a bit bigger The screw then cools down and resumes its original size, leaving the hole in the wood a size larger The writer has given this little kink a fair test in taking screws out of some oak boards that were built in a refrigerator where the wood had become set around the screws.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending January 24, 1911,

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Accelerator H E Wimperis 982,336
Acetylene generator F B Ray 982,090
Acid and metal peroxid, making nitric or other oxynitrogen H S Blackmore 982 466
Acid di iodid, tartric Arnaud & Posternak 982,666
Adjustable bracket J Knape 982,279
Advertising device F Evans 982 355
Advertising device live motion Medvecky & Kauser 982 685
Air brake systems, testing device for F A. Gilfus 982 714
Air compressor F M Prather 982,683
Air forcing apparatus I H Spoor 982 893
Airship C L Anway 982 861
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Bottle non refillable T L Weig rt et al 982 52.
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Cut out electrically operated automatic F A Brown 982 846
Cylinder liner J W Moore 982 739
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A printed copy of the specification and drawing of any patent in the foregoing list or any patent in print issued since October 4th 1859 will be furnished from this office for 10 cents provided the name and number of the patent desired and the date be given Address Munn & Co Inc 361 Broadway New York.

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Some Mountain Winds and Their Names

BY FITZHUGH TALMAN

The march of human knowledge is from the particular to the general and the nomenclature of science moves in the same direction. The individual manifestations of a natural law are first observed and separately named the law itself comes to light later through the process of induction and science then finds itself burdened with a multitude of names for one and the same phenomenon

This fact is well illustrated in the history of wind nomenclature In the modern scientific classification of winds a score of names suffice for them all in an earlier generation Aeolus ruled over a populous kingdom and his subjects possessed for our forefathers an individuality that was expressed in a nomenclature of bewildering magnitude The wind called Euroclydon was to St Paul and his contemporaries an isolated and distinct entity that no one thought of linking up with the general atmospheric circulation of the Mediterranean and Milton's herald of the sea thought it necessary to question every gust of rugged wings about the fate of Lycidas when he might better have applied at once to headquarters i e to the center of the cyclonic storm that was sweeping the British seas when the unfortunate young Cantabrigian came to grief

We now know that all mountain winds can be classified as (1) local breezes of diurnal period and (2) local modifications of more general winds To the former class belong (a) the normal mountain and valley breezes due to the alternate heating and cooling of the valley bottom and the mountain slopes and blowing up valley by day and down valley by night (b) breezes of reverse direction—down valley by day and up-valley by night—which occur when the circulation of a valley is overpowered by the more active circulation of an adjacent valley—a phenomenon of which the Malojawind of the Upper Engadine is the classic example and (c) down-cast diurnal winds which occur when the mountain-sides are covered with snow and ice and hence are colder than the surrounding air Winds of the last class are typified in the *nevado storms* of the Andes described by Moritz Wagner and I propose to call these *snow-winds* in the absence of any other well established generic name Such winds are as Hann has told us regularly observed at the foot of glaciers on warm days

Of the general winds that take on special characteristics when they traverse a mountainous country there are two important groups each of which bears the name of its most prominent representative These are the *foehn* winds or *foehns* and the *bora* winds which might with propriety be called *boras* Both the foehn and the bora are descending winds or *fall winds* but while the former is intensely heated and dried in the process of its descent the latter which blows from a cold inland mountainous region to a relatively warm coast although also warmed to some extent retains the character of a cold wind The explanation of these processes is given in every treatise on meteorology or physical geography and need not be repeated here

The alternating day and night breezes of mountain valleys may be so gentle as to escape notice or so strong as to excite interest and wonder according to the configuration of the valley and the sharpness of the contrast between the diurnal and nocturnal temperatures Before the days of scientific generalizations on this subject such of these breezes as were especially strong and regular were apt to be given individual names a great number of which still survive

The local winds of the western Alps were first thoroughly studied about seventy years ago by J Fournet and to him we are chiefly indebted for our knowledge of their nomenclature The most famous of these breezes is the *pontias* This is a cold nocturnal wind blowing out of a narrow valley that opens upon the plains of the Rhone near the town of Nyons, which once bore the sobriquet *Pontias* due to the presence in its neighborhood of an old Roman bridge (pons) This *ventus pontiacus*—also called *le vent de St Césarée d'Arles* has been known from time immemorial and was the subject of many speculative disquisitions before modern science was brought to bear upon it Tradition ascribes the origin of this wind to the beneficence of St Cæsarius Archbishop of Arles who is said to have brought it from the sea in a glove for the purpose of improving the fertility of the valley In reference to this legend an alternative etymology of the name *pontias* derives it from the Greek and Latin *pontus* the sea The peasants claim that the olive trees upon which this wind blows produce fruit of a superior quality and that its cessation is an omen of pestilence

In the same valley with the *pontias* the up-valley day breeze is called *vesine* a name which Fournet tells us means bad wind Good authority however derives this word from the name of a former division of Provence viz Venaissin from the direction of which the wind blows

Another local breeze of the French Alps is the *solore* or *solaure*, which blows at Saillans, along the narrow valley of the Drôme Its diurnal periodicity is expressed in the name which is equivalent to *sol* + *aura*, sun breeze To the western Alps also belong the *vent du mont Blanc* (Mont Blanc wind), the *aloup de vent* (wind wolf), blowing by night down the valley of the Brevenne and the *joran* blowing down from the Jura mountains (whence the name) to the shore of Lake Geneva The *joran* Forel tells us does not blow out onto the lake but another wind does, viz., the *morget* which is not a mountain breeze but a regular nocturnal land breeze alternating with a diurnal lake breeze called the *rebat* The *morget* and the *rebat* are the homologues of the alternating land and sea breezes of ocean coasts The *morget* is named from the town Morges *rebat* is evidently from the French *rebattre* in some one of its senses

The Italian lakes are especially rich in local wind names only a few of which can be mentioned here On Lake Como the day breeze blowing toward the head of the lake is called *la breva* the opposite night breeze *tivano* On Lake Garda, and in the neighboring Etsch valley the regular day breeze blowing up-valley is the *ora*—probably an archaic form of the Italian word *aura* breeze The northerly night breeze is called *sover* or *sopero* i e upper wind Just as on the lakes of the Austrian Salzkammergut the night wind blowing from the upper end of the lake is called *Oberwind* its opposite by day being the *Unterwind* or *Niederwind* Lake Garda has a score of other wind names a list of which is given by F Denza in his Italian version of Scott's Elementary Meteorology on page 498

Of the many other local breezes that have special names I shall mention only the *Wisperwind* the cold night breeze that blows out of the valley of the Wisper a small affluent of the Rhine and the *Erlerwind* which blows in the Inn valley north of Kufstein in the Tyrol

Turning now to winds belonging to the more extensive circulatory systems of the atmosphere we come first to the *foehn* which is undoubtedly the most interesting of mountain winds The word *foehn* became naturalized in English before the German umlaut lost its e and the old spelling is generally retained in English texts though the modern German form *föhn* is also met with An argument in favor of the older form is the fact that the transition from *fohn* to *fohn* would be temptingly easy at least to cis Atlantic writers—and especially to cis Atlantic printers—and antiquated German is preferable to a barbarous anglicization *Fön* is an alternative spelling in German

The history of the word *foehn* has been traced by R Billwiller and is a striking illustration of the vicissitudes that many wind names have undergone In the classical Latin wind rose the west wind was called *favonius* i e the beneficent wind (from the verb *faveo*) so called because it brought mild weather melted the snow in spring and promoted the growth of plants While to the mariner, in all ages the direction from which a wind blows is its most important characteristic the agriculturist is more interested in its physical qualities and their effects It is therefore not surprising that the Italian peasants who migrated to the northern slopes of the Alps transferred the name *favonius* to the wind that had the physical characteristics of the west wind in Italy and this was the warm wind from the south In the Rhaeto-Romanic dialects *favonius* became *favougn favoign fuogn fuin* etc. later Germanized into *foehn* The evolution of the word however did not stop here When the scientific study of the foehn was begun its high temperature was accounted for by the hypothesis that it was a sirocco wind from the African deserts which after traveling northward at a great altitude was in some manner brought down to the earth after passing the Alps Dove thought it was an anti trade wind from the Caribbean Sea So far the name belonged exclusively to the Alpine region The true theory of the foehn was given by Espy and more fully by Hann It was discovered that the foehn was simply a descending air current, heated by compression and dry in consequence of having lost its moisture through condensation and precipitation during a previous ascent Given this conception of the foehn, it was inevitable that the same phenomenon must occur in other parts of the world, and it was in fact found that the foehn is fairly common in mountainous regions everywhere and has in many cases been given local names—*chinook* in western America, *zonda* in Argentina *autan* in the south of France etc Thus *foehn* became a generic name for a very numerous class of winds In its widest extension the word is not even limited to mountain winds but is applied to *any* current of air that is heated and dried by compression during descent, and meteorologists to-day write of the anticyclonic foehn that gives warm weather and clear skies to the belt of descending air bordering a barometric depression

The Alpine foehn has a large nomenclature both scientific and popular A *wilder Föhn* is especially violent a "*Dimmerföhn* relatively weak. The *foehn wall* (*Föhnmauer*) is the fringe of cloud that forms along the crest of the mountains over which a foehn is blowing "Foehn sickness" is alleged to be experienced by some people during the prevalence of this wind. The foehn is nicknamed "*Schneefresser*" ("snow eater"), because it causes the snow to disappear with marvelous rapidity, the Alpine peasants have a saying that a day of foehn is as good as a fortnight of sunshine. The name snow eater" is likewise applied in western America to the chinook. In northern Tyrol and Vorarlberg the foehn is called "*Türkenreifer*" ("maize ripener), in Graubünden its sobriquet is "*Traubenkocher*' (grape cooker'), in some parts of the Tyrol it is *Mailänder*, because it blows from the direction of Milan

With regard to the American *chinook* it need only be noted here that while the scientific chinook is always a foehn the chinook of popular parlance may be almost any warm wind Similarly, in Argentina the name *zonda* is applied not only to the westerly foehn wind, but also to a northerly sirocco wind As to the etymology of these words, *chinook* is from the name of a family of Indian tribes settled along the Columbia River but exactly why their name was applied to the wind is unknown *zonda* is from the village of Zonda, in South America.

The *autan*, of southern France is a recent addition to the foehn family i e, the fact that it is a foehn has only lately been discovered through the investigations of E de Martonne professor of geography at the Sorbonne It is a violent dry wind from the south or southeast, prevailing on the Atlantic slope of Haut Languedoc and in eastern Aquitaine and has been found to be really an extension of a moist wind the *marin*, blowing from the Mediterranean on the opposite side of the mountains

In a recent letter to the author M de Martonne sends an interesting piece of information not heretofore published concerning the *autan* One of his philological colleagues has investigated the etymology of this word, and finds that it comes from the Latin *altanus* which usually meant a wind from the sea (*ex alto*) This seems to argue that the identity of the *autan* with the *marin* was recognized from early times However, this conclusion must not be too hastily accepted since the word *altanus* was undoubtedly variously applied by classical writers and we have seen in the case of *favonius* how easily the ancient names of the winds were diverted from their original meanings

As to the *bora* which as a generic term includes the *mistral* of southern France I shall say only a word regarding the terminology of the Adriatic bora, which is the type specimen of its class. A moderate bora is called *borina* a very heavy one *boraccia*—and whoever has experienced the ferocity of a boraccia will bear witness that the Italian pejorative suffix is fittingly applied The wind blows in violent gusts called *refoli* or *raffiche* and fills the air over the sea with a mist of driving spray the *fumarea* or *spalmeggio*

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Electric Car Lighting*

The Development of a New Branch of Engineering

By D. F. Crawford, General Superintendent of Motive Power of the Pennsylvania Lines

It is not the scope of this paper to go into the history of car lighting and the various elements in connection with the same but merely to discuss the general proposition various systems the recent development of the same and their applicability to the various conditions to be met

Electric car lighting at this date is comparatively a new branch of engineering and its development within the past nine or ten years has removed it from the unsatisfactory experimental stage to a real and serviceable proposition There is still however, much to be desired in detail development and reduction of costs In other words the car lighting proposition is just emerging from its swaddling clothes and is a good healthy child which however needs considerable care and attention to develop it along the most satisfactory and economical lines

Electric car lighting is the last step that has been made in the lighting of passenger cars through the chain of candles kerosene acetylene and gas The reason for its adoption was primarily on account of the danger of fires with gas lighting on the occasion of wrecks Among the minor reasons for its adoption is the greater ease in controlling the amount of light desired in cars the elimination of a great percentage of heat and the furnishing of a light which would not in any way contaminate the air in the car

METHODS IN VOGUE.

At present there are four methods being developed

First —The straight storage with 30 or 60 volts This consists of storage batteries held under the cars current from which is distributed through a small panel board to the various circuits

Second —The axle generator This system is simply a straight storage system augmented by a generator driven from the car axle which by automatic means is thrown across the battery circuit when its voltage is equal or above the batteries thus charging the car en route, and (theoretically) doing away with the necessity of charging the car at terminals

Third —The head end system in which the prime mover is installed in a baggage car By this system a current is transmitted through a continuous train line to the various cars The present voltages in vogue are 60 and 110 With the 60-volt equipment as a rule each car is provided with a set of batteries by itself floating across the line With the 110-volt system one or two sets of batteries, as a rule are installed preferable one set on the observation and one set in the composite car that is, as both ends of the train

Fourth —The head-end system with the prime mover on the locomotive This system consists primarily of a steam driven generator mounted on the locomotive and furnishing current at 60 volts through train line to various cars each car being equipped with a battery

METHOD TO BE USED DETERMINED BY CONDITIONS

As yet no one of these methods has shown any decided superiority over another and the whole question is necessarily controlled by the conditions of operation to be met on the various railroads Where the lighting between charging stations is within 70 or 80 per cent of the capacity of the battery which within reason can be carried under the car and where the time of lay-over for the cars and conditions at a terminal are such that the batteries can be properly charged it is the writer's opinion that the straight storage system is the most efficient, most economical and is giving the best results from the standpoint of continuous service There are, however conditions where either the lighting load of the car is so great or the lighting hours of such duration that even with the proper terminal facilities it is impracticable to carry sufficient battery on the car to meet the demand —here we enter the sphere of axle lighting It is plainly evident then that neither the straight storage or the axle light system is capable of meeting any and all conditions of car lighting. There are various railroads that have adopted the axle lighting system as a standard equipment for all cars including passenger cars with small lighting output, while other roads find it practicable to take care of their coaches by straight storage and the dining cars business cars and postal cars with axle dynamo

The idea in the essential development of head-end system is to do away with both the straight storage and the axle light cars and to furnish current for the lights on all cars in all trains from head-end equipment a battery of medium capacity to be installed on each of the cars in order to furnish current when engines are being changed when the train is broken up by switching and in the event of the failure of the generating unit. It is doubtful if this development will ever be realized and it leaves for the engineers the choice between the two tangible systems—straight storage or axle device

THE RECENT DEVELOPMENT OF THE VARIOUS SYSTEMS AND THE ELEMENTS OF THE SAME

In any system of car lighting the element of greatest importance and the maintenance of which is rather a large per cent of the total cost is the storage battery This branch is of such importance and its development has been so great that the writer feels justified in taking up some time in going into the history operation and development.

The first practical storage battery was developed in 1860 in France, by Planté The essential scheme as outlined by Plante in the making of the battery was to take two lead plates emerge them in sulphuric acid of about 1 200 degrees specific gravity and charge and discharge them forming the active material on the lead peroxide of lead being formed on the positive plate and spongy lead on the negative plate This method is carried out to-day by the American manufacturer of storage batteries with the exception that various chemical means have been resorted to to increase the rate of the formation of the active material This process is known as a plante formation and plates made in this manner are known as plante plates

A satisfactory theory of the lead sulphuric cell is still to be developed but I will give you the following simple and generally accepted explanation of its action

We will consider that we have a glass jar filled with 1 200 degrees sulphuric acid and emerge in it two pure lead plates Now with a voltmeter across these plates we will find that there is no difference in potential Now, assume that an electric current is passed through this cell from one plate to the other calling the plate to which the positive lead is attached the positive plate and the other plate the negative This current we will assume separates the sulphuric acid H_2SO_4 into two parts or ions H and the radical SO The H ions move in the direction of the current or toward the negative plate and the SO_4 moves against the direction of the current or toward the positive plate The hydrogen will be given off as gas bubbles at the negative plate and the SO_4 radical will unite with the water at the positive plate forming sulphuric acid H_2SO_4 and liberating oxygen The oxygen attacks the positive plate forming a layer of peroxide of lead PbO_2 This process will be kept up until a certain depth of peroxide of lead is formed then the oxygen will be delivered at the positive plate in the form of gas bubbles similar to the liberation of hydrogen at the negative plate. Now if we stop the current we will find instead of zero potential between the plates that we have a potential of about 2 1 volts and that the cell is capable of discharging that is producing current in an outside circuit and will give up about 75 per cent of the energy that has been imparted to it The action in the cell on discharge is opposite to that on charge and the hydrogen which is liberated at the positive plate will reduce the peroxide PbO_2 to lead oxide which is an unstable combination and will unite with the free sulphuric acid forming lead sulphate or $PbSO_4$ while the oxygen delivered at the negative plate will form lead oxide which will unite with the sulphuric acid forming lead sulphate and we have the cell in normally discharged condition or both plates covered with lead sulphate On again charging the cell that is passing current through it from positive to negative from an outside source the same action will take place as on the original charge with the exception that at the negative plate the hydrogen instead of being liberated will unite with the lead sulphate $PbSO_4$ forming sulphuric acid and reducing the $PbSO_4$ to metallic lead which lead however is not in its original form but is in a looser allotropic form known as spongy lead We then have the plate in its normal charged condition the positive plate having a coating of PbO_2, or probably PbO_2, which is of a dark brown color and the negative plate covered with spongy lead which is light gray in color As in the first case the charge can be continued the peroxide being formed on the positive plate and the spongy lead on the negative plate until the action has reached a certain depth when as before, hydrogen will begin to be delivered at the negative plate and oxygen at the positive plate indicating the full charge of the battery

Now, with a plain lead sheet this action of charge and discharge can be continued with gradually increasing capacity of the element until the active material has reached such a depth that it will mechanically slough off at the same rate at which it is formed The capacity depends upon the amount of active material and as this amount of active material depends upon the surface exposed, the development of the plante plate has been along the lines of increasing the exposed surface of the plate and still maintaining the mechanical strength, and this has been done by the various methods of molding, cutting or rolling the sheet, so as to form ribs or grid condition to increase the ratio of the active surface to the projected surface of the plate.

A wide departure from the plante plate was made in 1878 by Faure and Metzger in Germany in the invention of what is known as the Faure' or 'pasted plate Instead of depending upon the electrochemical formation of active material on the surface of the plate Faure took a sheet of lead and punched it full of holes or in some cases the grid is cast, and the holes or recesses thus formed are pasted full of a mixture of red lead and sulphuric acid This paste or litharge, as it is called in the recesses of the plate forms a hard cement like substance, and, when the negatives and the positives are charged the plates are quickly formed into positives and negatives the positives turning into lead peroxide and the negatives into spongy lead It can be readily seen that the pasted plate can be developed into cells having considerable more capacity than the plante plate and we have the pasted plates in commercial use in connection with automobiles The pasted plate is better adapted to light rates of charge and discharge and will not stand up under heavy rates of charge and discharge as the plante plate due to the contraction and expansion of the active material which results in the breaking down of the electro-chemical contact of the active material to the supporting grid

About nine or ten years ago when the storage batteries began to be used to any extent in car lighting the battery manufacturer had, for some years been furnishing storage batteries for stationary service but unfortunately the conditions of car lighting are exceedingly hard on the storage battery, due to the constant vibration the jolting of the cars and further to the inadequate attention that can be given to the individual batteries and cells in an installation of any magnitude The normal battery used for car lighting purposes is a 280 ampere hour cell where 16 or 32 cells are used per car dependent upon whether the car is to have 30 or 60 volt lamps. There were three principal types of plates offered

First—The pasted positives and negative plate which were not found satisfactory for the service, on account of the active material being loosened up in the supporting grid and dropping to the bottom of the tanks the life of the plates being everything but satisfactory and the resultant cost of operation being high

Second—The positive plate is composed of a grid about 3/16 inch to ¼ inch thick punched full of holes about ½ inch in diameter Into these holes is pressed a button of pure lead This button is made by rolling in a spiral form a corrugated, pure lead ribbon In through coach and axle dynamo equipments, this type of plate is found to have very short life and proved to be entirely unsatisfactory for the service The manufacturer of this plate has kept pace with the development and to-day is furnishing a plante plate similar to the original with the exception that the supporting grid has been made twice the former thickness, or practically the thickness of the button, and present experience seems to indicate that this plate is far superior to the original product and will successfully meet car-lighting conditions.

Third—In the original plante battery offered for car lighting service the positive plate consisted of a pure lead grid, which had a surface developed by means of passing over it a band saw, sawing out grooves about ¼ inch or 3/16 inch deep, and a little less than 1/16 inch in width. This plate was originally pasted full of active material, which, however, fell out very rapidly, leaving only plante formation. In this condition the life of the plate was good, but the difficulties of developing sufficient surface in this method prevented its successful use, the surface being insufficient to maintain necessary active material for the capacity desired. The plante plate is now used in both negative and positive plates, the surface [illegible]

* The Yale Scientific Monthly

formed by either spinning out the lead in the ribs, by means of revolving gang knives, or by cutting and turning up the fine ribs by means of shaper knives the ribs being from 24 to 30 per inch and about 3/16 inch in depth

The plante plate was the first plate developed to successfully meet the car lighting conditions it being capable of maintaining its capacity for a big percentage of its life and being sufficiently rugged to withstand the vibration and hard knocks met with in car lighting

Recently a number of plates have been put upon the market which the manufacturer expects to meet the conditions and notably among them is a cast plante form positive plate the plate being about 7/16 inch thick and having cast through it is a series of slots less than 1/16 inch in width and about ½ inch long To date, this plate shows indications of being satisfactory for car lighting service Another type of plate recently put on the market is a cast grid and grill pate the grid being cast with openings about three inches square made of lead antimony and a pure lead grill similar to the positive plate mentioned above being burnt into these openings with sufficient allowance being made for contraction and expansion This plate is rather new and it is hard to say what the results of development along this line will bring forth The above types are most used in car lighting work but there are however numerous plates of unique design placed on the market from time to time and for which great claims have been made but which to date have not met their guarantee sufficiently to make them competitors with the plates to win service

The recent development of the Tungsten lamp for car lighting purposes and the development of the serviceable ampere hour meter may make it possible for car lighting engineers to go back to the pasted battery for the reason that

First.—The Tungsten lamp reduces the rate of discharge on a given car to about half the rate with carbon lamps and the ampere hour meter installed with 100 per cent shunt for discharge and 80 per cent shunt for charge makes it possible for the electricians at terminals to give batteries the proper charge tapering charge at completion and cutting off charge without abusing the batteries by heavy overcharge with the resultant gasing and high temperature Some of the railroads are making trials of the equipment as above mentioned but time only will tell whether or not they will be successful If the refinements in car lighting will allow the use of pasted batteries it will be advantageous both on account of the fact that the pasted batteries can be purchased for less money than the present car lighting types and are 25 to 30 per cent lighter

In regard to the Tungsten lamp itself there is no question but that this type of lamp will replace carbon lamps Its success is mainly due to the development of the so called hot circuit this being the method whereby instead of turning the current completely off from the lamp when lights are not required the lamp is merely switched from the main batteries to one or two hot circuit cells merely sufficient current being sent through the lamps to make the filament show faint red at night This arrangement prevents excessive breakage of Tungsten filament which is an unfortunate characteristic of the filament when it is cold

One of the greatest developments in car lighting work has been the containing jar The first batteries were installed in hard rubber jars with loose covers The jars were rather expensive and in shifting cars there was a continual breakage Further the slop of the acid was disastrous to the trays holding the rubber jars and the battery boxes supporting the batteries also the corroding of the terminals was excessive To do away with this trouble wooden tanks with 4-pound lead lining were developed and installed with loose covers This development proved to be very discouraging The slop of the acid rotted the tanks and the lead linings proceeded to develop sulphated spots between the wood and lead lining eventually terminating in pin holes through which the acid was lost The experience along this line was very expensive to the railroads adopting it However the advocates of the lead lining continued developments along this line and the first improvement was to cover the top of the tank with a full rubber gasket, and secure it with a wooden cover holding it in place with iron straps it being assumed that the rubber gasket pressed between the top of the lead lining and the wooden cover would sufficiently prevent slopping of acid and corrosion of terminals. This modification was an improvement but the question of leaky tanks continued and the railroad people had all they could do to keep their equipment in service.

From this stage, through a series of rapid developments, the present two-compartment lead lined tank was developed, which has proven entirely satisfactory The outside of lead tanks themselves is cleaned and covered with a coating of petrolyte, the inside of the wooden compartments is painted with acid-proof paint, and before installing the lead linings sufficient molten paraffine is poured into the wooden trap so that when the lead lining is put to place the paraf fine runs up between the lead lining and the wooden compartment completely filling this space The covers are now made of hard rubber the terminals projecting up through bushings of soft spongy rubber the covers being provided with sealing grooves to seal them with sealing compound to the lining This equipment is now standard on a number of roads and is proving to be entirely satisfactory although in engineering work there is probably nothing that is not subject to further improvement

DEVELOPMENT OF THE AXLE GENERATOR

In the installation of an axle generator on a car the engineer is met with conditions which make it anything but smooth sailing He has to drive the dynamo from an axle which does not have any constant relation to any part of the car The lateral displacement of an axle in the truck itself is about ¾ inch the vertical displacement about 2 inches Further the trucks are pivoted and can swing out of line with a car going around curves to a considerable extent Some of the first developments contemplated flexible positive drives through gears from the axle and the installation of a generator armature on the axle itself These did not meet with any great approval by the railroads first on account of the fact that the car axles have to be changed due to the wearing of the tread and the flanges and second the location of the machine made it rather inaccessible for inspection

These difficulties resulted in the development of what is known as the outside suspension which scheme with few exceptions is universally used The dynamo in this case is hung outside of the truck from bails or in a cradle and the belt is run from the generator pulley to a pulley mounted on the rough axle Belts however have a limited life and the losing of a belt en route as a rule means failure of the lights on the car or in most events of at least dim lights in service Recently a number of chain manufacturers have been offering chain drives for this service and it is hoped by the railroad people operating lighting systems that these chains will meet with success However it is too early to offer any opinion on the same The conditions of the driving axle with varying relation to the dynamo and the fact that it is absolutely impracticable to lubricate the chain puts the chain manufacturer up against a difficult proposition

The dynamo itself is not the joy of an ideal life the variations of track alignment and surface and the swinging of trucks around curves make it a hard proposition to maintain the lubrication of armature bearings and keep the oil from fields armature windings commutators and brushes The machine is necessarily devoid of any means of ventilation as dust and dirt of the right-of way must be prevented from getting into it The dynamo is used for charging batteries and lighting car and is driven by a variable speed axle and is liable to run in both directions therefore the control of this apparatus has been subject to numerous arrangements and patents To provide for the generating of current in one direction (the machine revolving in both directions) a pole changer is almost universally used This practically consists of two types first the brushes themselves are fastened to a movable brush ring and the friction of the brush revolves it in one direction or the other dependent upon the movement of the car so as to produce current in the proper direction and second a worm and cam arrangement which is in operation for the first few turns of the dynamo and changes the leads through means of a pole changer switch

The provisions for varying speed of the machine can be made in two ways First voltage regulating scheme whereby the voltage is maintained constant This would be the preferred arrangement but to date all attempts along this line have utilized instruments of such delicate construction that they have been unserviceable Second the universal scheme adopted is that of constant current. One of the first steps along this line with installation of a dynamo on the bottom of a car was the dynamo being so hung that it could be moved towards or away from the driving axle, and the varying speed of the car axle was taken care of by slippage of the belt This scheme worked out satisfactorily but practically could not be maintained The present and most universally used system is the arrangement of maintaining a constant current output from a generator by controlling the current flowing through the field One of the pioneers in this line used an ordinary rheostat two toothed wheels being mounted on the rheostat handle a dog engaging each one of them one dog to turn resistance into the rheostat and one to turn it out These dogs were made to revolve through a small arc by means of a constant running motor their contact with the respective wheels being made by means of a current solenoid This scheme for some time was the only equipment in service But in the development other schemes have been devised which are equally serviceable and have considerably less wearing parts and less liability of disarrangement. Among them is the immediate improvement of the above device in which motors dogs and cog were omitted and the controlling solenoid operates directly on the rheostat arm which swings up and down over the resistance contacts The other scheme is to provide a certain pile resistance in the field and the current solenoid brings varying pressure on a carbon pile depending upon the current and allowing more or less field excitation A rapid departure is made from the above equipments in a recent installation wherein all rheostats and regulators were omitted and the regulation is obtained by a counter E M F armature mounted on the main generator armature This counter E M F machine when the car starts up acts as an exciter its field being obtained from the battery current or in a constant direction Now as the car picks up in one direction or the other the current in the counter E M F machine will be in one direction or the other and reverse the direction of rotation of the main armature and the direction of its field excitation maintains a constant polarity As the machine picks up in speed the main contact closing the circuit of the batteries is closed and at the same time a little polarizing switch is installed whereby the excitation of the main generator is thrown across its own brushes as a shunt machine either in one direction or the other dependent upon the directions of rotation and the counter E M F machine is thrown in series with the current to the main fields and in opposite direction therefore when the car picks up speed the generator is prevented from increasing its current and voltage from the fact that the counter E M F machine also increases its voltage and cuts down the current going through the fields

In addition to the above arrangements there have been installed methods whereby machines can be set at constant current output and made to increase this output in proportion to the lighting lead thereby lighting the lamps directly and maintaining a constant charge to the batteries Developments have also been made recently along the line of cut-out switches so arranged that the machine can be cut down and battery charge ceases when the batteries have reached a predetermined voltage

The axle dynamo appeals to the car lighting engineer and in the writer's opinion if the equipment can be developed to meet the conditions and operate cheaper than the straight storage system they will be universally installed The ideal condition would be to install axle dynamos and batteries on cars so that they could run from one shopping to another with very little if any attention that is about 18 months and the regulation so perfected that no matter whether the car is in runs where very little lighting is required or in runs of continual night and lighting service that the condition would be properly matched

The event of the Tungsten lamp and the possible use of pasted batteries will tend to change some of the old theories in connection with axle dynamos The contention of the axle dynamo manufacturer has been that the installation of an axle dynamo allows the user to run his cars on 3 instead of 60 volts thereby doing away with the initial cost in the main tenance of half a set of batteries the reduced cost of the present battery and the possible use of the still cheaper pasted type of battery leaves very little if any argument in the above contention The plan of the car lighting engineers and axle generator people should be the development of a small sized machine which can be wound for either 30 or 60 volts with the same mechanical parts The 30 volt machine with 16 cells of batteries should be used on cars where the lighting needed is not over 15 amperes at 30 volts On the cars with greater lighting capacity the same machine wound for 60 volts should be used with 32 cells of batteries The above mentioned 60 volt equipment in view of the greater cost of the 30 volt machine to meet the greater lighting requirements will be as economical in operation as the 30 volt equipment but on the other hand will have more standby capacity with less lighting failures In the mean time the safest course of the car lighting engineer is to operate the straight storage system until such a time that the axle dynamo is properly developed to meet the conditions

Incense Powder.—Benzoin 250 parts cascarilla 250 parts musk 1 part sandal wood 500 parts saltpeter 100 parts vetiver root 150 parts frankincense 500 parts cinnamon 150 parts Dissolve the saltpeter in water soak the other pulverised ingredients with the solution dry the mass and re pulverise it This powder spread on a surface and moderately heated on an iron stove-lid for instance takes fire spontaneously and smoulders completely away

The Manufacture and Industrial Application of Ozone

The Possibilities of a Remarkable Gas

By Dr Oscar Linder

SINCE the discovery of ozone in 1840 by Schoenbein it has been a fascinating subject for investigation to many chemists and physicists The vast commercial possibilities of ozone have been conceived by many scientists and it is interesting to note the prophecy of Berthelot that ozone had an immense future and would ultimately work a veritable revolution in the chemical industry The scientific literature and the records of the Patent Office will bear proof of the at

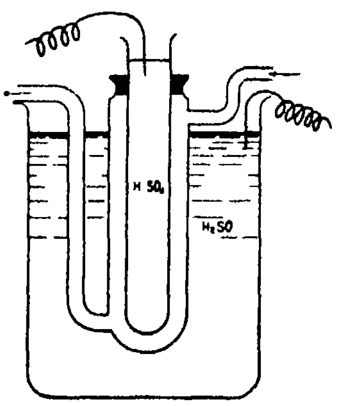


FIG 1—BERTHELOT OZONIZER

tention which has been paid to this remarkable gas by scientists throughout the world There have been more than one hundred patents issued by the United States Patent Office on methods and apparatus for producing ozone and the number of foreign patents is legion It is true that most of them are based on the original method of producing ozone by subjecting air to electrical stresses and most of the claims are but special arrangements and combination embodying this fundamental principle or means for producing the electrical stress However there are some notable exceptions such as for example methods of producing ozone by means of heat or ultra violet rays although the efficiency of these processes at the present time is too low to enable them to compete successfully with the electrical method

PROPERTIES AND OCCURRENCE

Every chemist and most laymen know that ozone is a gas with the composition O_3 and it is an allotropic modification of oxygen formed from the latter by an endothermic process According to Berthelot 29 600 calories are required to form 1 gramme molecule of ozone from oxygen Expressed in a popular way ozone may be called oxygen in a highly energized form As a gas it occurs or can be produced in greatly diluted form but it can be condensed to a deep blue liquid of a specific gravity of 1 46 which boils at —106 deg C (—159 deg F) according to some investigators and at —125 deg C (—191 deg F) according to other investigators It is very unstable in either form and upon standing decomposes slowly if greatly diluted and may do so explosively if in liquid form

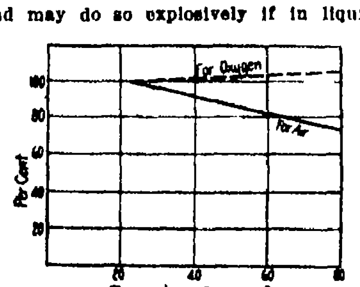


FIG 2—RELATIVE PRODUCTION OF OZONE AT DIFFERENT TEMPERATURES AS COMPARED WITH 22 DEG C (71 6 DEG F)

This decomposition increases with a rising temperature and at a temperature above 270 deg C (518 deg F) ozone cannot exist Its density as a gas is 1 66 air being 1

Ozone has a characteristic odor which is perceptible even when in extreme dilutions with air So delicate is our sense of smell to this gas that it is easily possible to detect the presence of one part ozone in about ten million parts air which would correspond to a concentration of 1/100 000 of 1 per cent It is the most powerful oxidizing agent known and will attack even when greatly diluted all oxidizable substances especially organic matter It is therefore a valuable oxidizing agent not only because of the ease of its application as a gas but also because no other elements are introduced into the reaction but oxygen

Ozone occurs in nature in the atmosphere and is supposed to be formed in small quantities through electric conditions of the atmosphere and by the action of ultra violet sun rays upon the atmospheric air The latter formation explains why it is more abundant in the higher regions where the ultra-violet rays are largely absorbed by the atmosphere The quantities in which ozone is present in the atmosphere is largely a matter of conjecture It has been given as from 0 1 to 12 parts in 1 000 000 parts by volume of air but most likely it is present, even where most abundant, in quantities of not more than 1 in 1 000 000 We are not going much wrong if we assume it to be about 1 part in 1 000 000 parts air 1/10 000 of 1 per cent or a little less than 1 milligramme per cubic meter air) The very fact that even in smaller concentrations than this its presence can be detected distinctly by our sense of smell while its detection by chemical means is at best uncertain must be taken as an indication of its importance

MANUFACTURE.

Ozone can be made in a number of different ways but the only method of commercial importance at the present time is its formation through electric stresses I might mention that a process of great interest and of commercial possibilities is the formation of ozone through the action of ultra violet rays upon air these rays being produced by means of a mercury vapor lamp inclosed in a quartz tube Another method of scientific interest is the production of ozone by means of heat in which Nernst and Clement obtained fair yields (as much as 3½ grams of ozone per kilowatt hour) by leading oxygen over incandescent bodies and cooling it immediately by liquid air F Fischer obtained equally good results by blowing air at a velocity of 70 meters per second through a slit 1 millimeter wide over a Nernst burner and then cooling it in a glass tube surrounded by water However at the present time these methods are too inefficient for commercial purposes

The apparatus designed by Berthelot a sketch of which is given in Fig 1 is the prototype of most ozonizers which are on the market at the present time Occasionally parallel plates are used in place of concentric tubes but in general there is very little difference between the different designs and makes except as to construction.

There may be either one or two layers of a dielectric material which is usually glass free from lead or mica separating two metal electrodes The latter are used mostly in the form of alluminium or tin foil pasted to the dielectric or sometimes solid metal or metal brushes which may or may not touch the dielectric The thickness of the dielectric layer is usually in the neighborhood of 3/32 inch and that of the air space about ⅛ inch but these dimensions depend of course largely on the character of the electric energy When the metal electrodes are connected to the opposite terminals of an alternating current of suitable frequency and voltage a so-called cold or silent discharge free from sparks takes place through the glass and is visible by a faint violet glow distributed evenly through the air space between the electrodes The air or oxygen to be ozonized is passed through this glow and is thereby ozonized It is not definitely known whether it is the stresses themselves which cause the ozonization of the air or whether it is due to the ultra violet rays which are generated in the air gap but the latter theory seems more probable at the present time It should be mentioned here that the use of oxygen instead of air while giving considerably higher yields and concentrations has been generally abandoned on account of the costliness of the oxygen A step-up transformer of high ratio and comparatively low current capacity constructed on the principle of potential transformer is always a part of an ozonizer except in cases where induction coils or static machines furnish the electrical energy

In order to understand the action of an ozonizer it is necessary to first dwell upon the influence of voltage heat and moisture on the generation of this gas and upon the relationship between yield and concentration

The amount of ozone which can be generated in an ozonizer of the Berthelot type is theoretically in direct proportion to the voltage of the discharge per unit of air ozonized This would be true in practice if it were not for the destructive action of heat on ozone There is a considerable amount of heat formed in the so-called cold or silent discharge and the heat thus generated increases of course as the square of the current of the discharge In using a high wattage of electric discharge per unit of air ozonized a condition which is necessary in order to obtain the high yields and concentrations required for industrial purposes it is desirable therefore to use as high a voltage and as low a current as feasible Most failures in ozone generators are due to insufficient understanding of this principle the natural

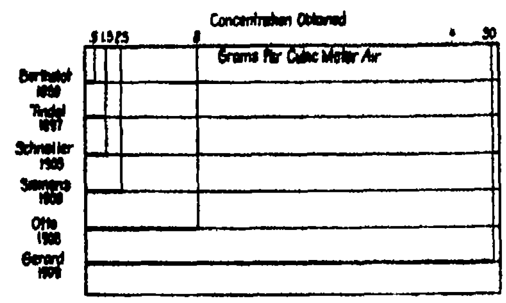


FIG 3—INCREASE IN 20 YEARS IN CONCENTRATION OF OZONIZED AIR

tendency of designers being to use as low a potential as possible There is no good reason for employing low voltages and it is now proven that contrary to former belief the formation of ozone is not limited to certain voltages or frequencies It is only at about 8 000 to 10 000 volts that the process of ozonization becomes economical and apparatus employing voltage below that are hopelessly low in efficiency for all purposes where both high yields and concentrations are required In former years limited knowledge of high potential transformers and other alternating current machinery made it necessary to use low voltages but at the present time the design and manufacture of small and efficient apparatus is of this kind affords no difficulties and there is therefore no necessity of restricting the voltage employed Voltages as high as 40 000 volts are now used and the most successful ozonizers are those which employ high voltages

The effect of heat on the formation of ozone is illustrated in the diagram shown in Fig 2 which is taken from L Gerard's treatise on ozone in the August number of the Proceedings of the Societe Belge d Electricians 1909 from which you can see that the production rapidly diminishes as the temperature increases After 80 deg C (177 deg F) it falls off still more rapidly and at 270 deg C (518 deg F) it is 0 The importance of keeping the electrodes as well as the air to be treated cool can readily be grasped from this diagram

The very best designed ozonizers still generate a sufficient amount of heat so that for commercial yields and concentrations it becomes necessary to resort to

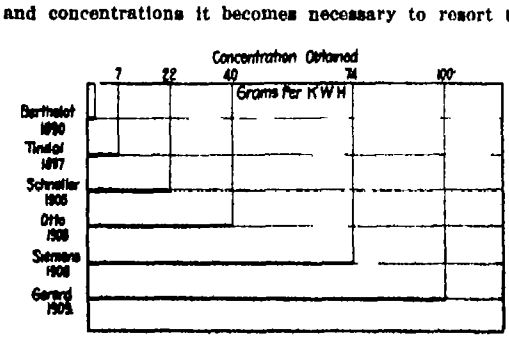


FIG 4—INCREASE IN 20 YEARS IN THE YIELD OF AN OZONIZER

artificial cooling of the electrodes or of the air to be ozonized Some designers have even resorted to refrigeration of the air before ozonization and some very good results have been obtained thus but it should be said that refrigeration is not necessary in small apparatus if sufficiently high voltages are used although for low voltage discharges it is perhaps the only means of obtaining anywhere near commercial yields

The concentration of ozonized air is the amount of ozone expressed in grams contained in one cubic meter air, and is a very important factor in all processes in which ozone is used The yield of an ozonizer is usually expressed by giving the amount of ozone generated in grams per kilowatt hour electric energy consumed. The latter includes the transformer losses

* Paper read at the ... of the American ... of Chem... Engineers at the meeting held June 24th 1910 at Niagara Falls N Y

but no other auxiliary apparatus Much progress has been made during the last 20 years in both concentrations and yields obtained as shown in Figs 3 and 4, which are taken from Gerard's above noted treatise You will notice that concentrations as high as 30 grammes per cubic meter air which would correspond to two per cent by volume and yields as high as 100 grammes per kilowatt hour have been obtained Very recently even higher yields have been achieved in an experimental plant built on the Steynis refrigerating system which is reported to have given never less than 105 grammes and sometimes as high as 250 grammes of ozone per kilowatt hour at a concentration of about 4 grammes

Unfortunately an ozonizer is in its action similar to a storage battery and it is at the present time impossible to obtain the highest concentration at the greatest efficiency and an increase in the concentration will bring with it a decrease in the yield or *vice versa*. This is easily understood when the heating effect of the discharge is considered In running an ozonizer at a high concentration the wattage of the electrical discharge per unit of air to be ozonized must be high and this necessitates a slow rate of flow of the air to be ozonized or a high density of discharge per unit of electrode surface Both these conditions favor excessive heating of the air during ozonization and this we have seen is unfavorable to a large yield On the other hand in running an ozonizer at a high yield the most effective cooling of the electrodes is necessary and can be best obtained by circulating through the electric glow a large volume of air resulting of course in lowered concentration (see Fig 5) It is evident that this relation between concentration and yield being due to the heating effect of the discharge will be all the more favorable from a commercial standpoint the higher the voltage employed

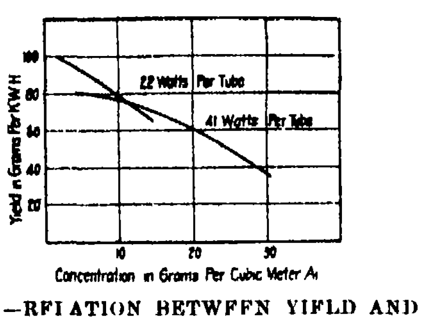


FIG 5—RELATION BETWEEN YIELD AND CONCENTRATION OF GERARD OZONIZER

The density and discharge per unit electrode surface is a factor depending largely on the design of the apparatus and on the voltage and rate of flow of the air through the apparatus As a general rule it is considered good practice not to exceed 0 4 watt per square centimeter electrode surface

The effect of humidity of the atmosphere on the production of ozone is shown in Fig 6 The presence in the air to be ozonized of water vapor so greatly reduces the production of ozone that for all commercial concentrations except for ventilation it is necessary to dry the air before ozonizing it This practice is followed in almost all instances and is usually accomplished by passing the air through a tank containing lime before passing it through the ozonizer or in large plants by refrigeration

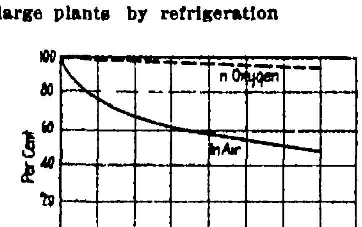


FIG 6—RELATIVE PRODUCTION OF OZONE AS A FUNCTION OF HUMIDITY

It must be understood that where very low concentrations only are required such as for ventilating cooling and drying of the air In a well designed apparatus of this kind sufficient cooling is accomplished preferably by the artificial circulation of the air set up and the reduced production of ozone in the presence of such water vapor can be taken care of by making the apparatus adjustable

In subjecting air or oxygen to the effect of electric stresses, it is well known that some other products are formed besides ozone. If water vapor is present in the air or oxygen, there may be some hydrogen peroxide formed. However, the drying of the air before ozonization does away with this possibility In small ozonizers used for ventilating purposes in which it is not customary to dry the air, the amount of hydrogen peroxide formed is so small and the dilution so great that its presence can be disregarded, especially considering the great similarity in action between hydrogen peroxide and ozone

Besides hydrogen peroxide there is always formed a more or less small amount of the oxides of nitrogen Their presence in the ozonized air is highly undesirable and should be carefully avoided The formation of these oxides is favored by heat sparks dust and dirt, and it is therefore important in the construction of ozonizers not only to provide sufficient cooling but also to prevent the formation of disruptive discharges or sparks in place of the cold or silent discharge during the operation of the apparatus The formation of sparks is favored by the accumulation of dust and dirt in the air space therefore in the design of ozonizers it is very important that particular attention be paid to the necessity of keeping the air space clean and free from accumulation of dust and dirt The amount of nitrous oxides formed is as a rule very small In well designed ozonizors there should not be more than one or two per cent of nitrous oxides formed figured on the amount of ozone generated In poorly designed apparatus the amount of nitrous oxides formed may run up to five or ten times this amount

During ozonization the air to be treated must be kept in positive motion a fan blower or air pump is therefore a necessary accessory of every well designed ozonizer

In regard to the quantitative determination of ozone it should be said that most of the figures which we find in the literature up to about ten years ago are unreliable owing to defective methods At the present time the determination of ozone in the higher concentration does not afford any difficulties but in low concentrations such as in the atmospheric air accurate determinations are even now impossible For industrial use the method now considered standard is the absorption of ozone by means of a neutral potassium iodide solution The iodine set free by the ozone is titrated after acidifying in the regular way by means of sodium thiosulphate and starch The hydrogen peroxide which may be found in the presence of vapor in the air to be ozonized is best eliminated by passing the ozonized air over finely divided chromic acid crystals before passing it through potassium iodide solution For very small concentrations manganese chloride paper in conjunction with Quajak tincture or Thallium suboxide as recommended by Engler and Wild and also the well known tetra base paper are giving fair comparativ results They are not however accurate enough for determining quantitatively the amount of ozone in the atmospheric air

It is not the intention of this paper to go into details as regards various apparatus for producing ozone as there are a number of treatises available where this information can be obtained For example the book on ozone by Henry Lecoux the paper on ozone by Leon Gerard in the August number of the Proceedings of the Société d Electriciens 1909 the various papers by Ehrlwein F Fischer Warburg and many others some of which I mention in this paper Most plants where a large amount of ozone is consumed have been designed specially to suit the conditions of one particular problem Therefore there is no such thing as standardization in this line and the number of designs so far is nearly as great as the number of installations

The first ozonizer constructed to meet with some success was that of Berthelot in 1899 a sketch of which is given in Fig 1 The general principle of this apparatus has not been changed to any great extent by later investigators although changes in details of construction and the progress in our knowledge of alternating current machinery made it possible for later designers to greatly increase its efficiency

The best known of the ozonizors of recent date working on the Berthelot principle is that designed by the engineers of the Siemens & Halske Co whose comprehensive investigations and publications have done much to bring the subject to the attention of the technical world A still more recent design and and which has achieved considerable success is that of Gerard a sketch of which is given in Fig 7

INDUSTRIAL APPLICATION

The industrial application of ozone has been delayed greatly in the past by unusual requirements set up by the manufacturers of such apparatus in regard to the nature of the electric current supply Until comparatively recently it was necessary to use static machines or induction coils run by primary batteries in order to obtain a discharge of the characteristics recommended by the manufacturers and even today the use of interrupted direct current or of alternating current of frequencies not met with in practice are prescribed for some apparatus It is no wonder that under such conditions the use of ozonizers has made slow progress but fortunately it has been found that the regular alternating current of commercial frequencies can be used just as well and in most cases to better advantage, than many special forms of electrical energy recommended in the past Thus it is now possible to purchase ozonizers operating from alternating lighting circuits without further electrical apparatus than a transformer In places where direct current only is available we can convert it into an alternating current of the desired frequency by means of a small and inexpensive converter several types of which are now on the market for that purpose Small ozonizers for ventilating purposes are even made so complete and compact that they can be connected to any electric light socket by means of a screw plug and cord and they can be obtained for any commercial voltage either alternating or direct current.

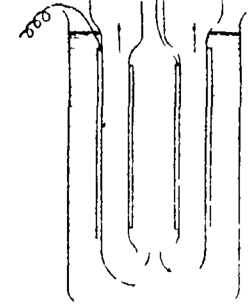


FIG 7—GERARD OZONIZER

Water Purification—The subject of water purification by means of ozone has been so extensively treated and discussed in the past that it is not necessary to go into details The success of this method of water purification has been definitely proven and it has been found that in large installations it is not only much safer and more effective but also cheaper than quartz filtration and requires much less space Large installations for water purification are as a rule designed specially to suit the requirements of one particular problem therefore the subject can not well be treated generally with other uses of ozone

The bactericidal properties of ozone since having been studied and proven by Froehlich and Chimuller have perhaps been more frequently investigated than any other of its properties and the fact that bacteriologists like Pasteur Roux and Koch have endorsed them has left no further doubt in the minds of the most skeptical persons Ozone oxidizes the impurities in water and renders them harmless It clears dirty water and still leaves no compounds harmful to the health or disagreeable to the taste This purification is accompanied by a distinct phosphorescence of the water In cases where muddy appearance is largely due to substances of mineral origin it is customary to partially clear the water by means of a pressure filter before ozonization At different times it is customary to use about twice as much ozone as is found necessary to thoroughly purify an average sample of the water in the laboratory The concentrations used for water purification are high and range from 5 to 12 grams of ozone per cubic meter (35 3 cubic feet) of air according to the quality of water The amount of ozone required for purifying one cubic meter of water also varies greatly according to the quality of the water but may be given as from 0 5 gramme to 10 grammes ozone per cubic meter of water The above figures represent about the limits ever used for purifying water of any kind

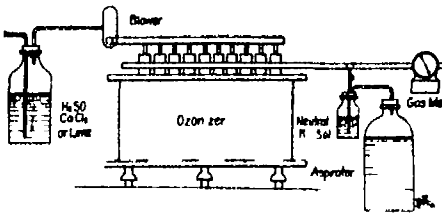


FIG 8—APPARATUS FOR USE IN THE APPLICATION OF OZONE

Owing to the low solubility of ozone in water (it is given as from 5 to 10 parts in 1 000 parts water) a very intimate contact between ozonized air and water is necessary and this is usually accomplished in towers constructed on the principle of the absorbing tower or by sprays and injectors

There seems to be no close agreement between the figures published about the cost of operation of the water purifying plants now in operation but a perusal of the data available would show the cost of purifying including interest depreciation and maintenance as being from 0 1 to 0 4 cent per cubic meter or from $3 80 to $15 per million gallons according to the quality of the water to be purified

Ventilation—One of the newest fields for the application of ozone is in the ventilation of rooms and buildings Good ventilation is being appreciated more and more because of the physical comfort which

it affords as well as because of its therapeutic and hygienic importance In all modern buildings, theaters passenger boats hotels etc, a ventilating system is an important part of the equipment and even in places the very name of which is associated with bad air such as street cars sleeping cars tunnels etc the feasibility of supplying good air is being seriously studied Up to the present time the problems of ventilation have mostly been categorically solved by heating or cooling the air to the proper temperature and in some few cases by filtering it through a sheet of water or a solid filter Recently however the demand has arisen to improve the air by charging it with ozone to a concentration corresponding to the normal percentage found in places noted for the purity and freshness of the atmosphere

It has been found and demonstrated that the presence of ozone in air in small quantities has a beneficial physiological action It gives it a pleasant and cheerful effect which is not noticed in air free from ozone It stimulates the appetite and produces sound sleep Its action has been compared with the effect of moderate physical exercises upon the general condition of body and mind Physical examinations of people working in places which are supplied with poor air have disclosed a decided gain in weight and chest measure after ozonizing their air supply for some weeks

Ozone is now considered a necessary constituent of good atmospheric air It is well known that air in cities and in all well populated places is depleted of or entirely free from ozone owing to the abundance of oxidizable organic matter in such districts The absence of such floating matter in the open country and especially in the mountains and on the sea is held accountable for the presence of ozone and for the general healthiness at such places

The question how to improve the air in cities and in closed places where people congregate is a problem which is just now receiving some serious attention for the reason that by far the largest percentage of deaths among the adults in cities is due to diseases resulting from bad air Perhaps the greatest destination of ozonizers is in the field of improving general air conditions for the powerful oxidizing properties of ozone can be put to a particularly practical use for purifying and deodorizing air Indeed it has been found that foul gases organic matter floating in the air offensive odors and everything else which is commonly called air sewage is thoroughly oxydized and destroyed by ozone Ozone in high concentration will kill any germ known to science In concentration for breathing purposes its action is different It is well known that this matter which we have defined as air sewage is a specially attractive ground for bacteria, miasmata and other animal and plant life of the lowest order which thrive in cities and congested districts In such small concentrations as ozone is employed in ventilation its beneficial action is probably its destruction of organic purposes it is usually unnecessary to employ artificial matter in the air rather than the direct destruction of bacteria which has sometimes been accredited to it It has not been proven that ozone when diluted to the extent of one part in one million parts of air can act directly as a bactericide but it is an established fact that even in such dilutions it acts as a deodorizer and destroyer of the food and favorite surroundings of the bacteria thus depriving them of the conditions favorable to their propagation So energetic is the action of ozone on such undesirable matter that the presence in the air of ozone can be taken as an indication of the purity of the air

Ozonizers made specially for ventilating purposes are now on the market and are made either of portable or stationary type There are several systems manufactured in this country and in Europe the latest one on the domestic market is made either for alternating or direct current and in various sizes to suit the requirements of the air space to be taken care of and is portable self-contained and adjustable The general plan of these machines is to draw in the air to be ozonized and subject it to electrical stresses by passing it through an air gap in which a silent electric discharge takes place and then discharge it immediately to the outside air

The cost of operation of such ozonizers is as a rule very low The consumption of electric current is about 65 watts for circulating and ozonizing 10 000 to 15 000 cubic feet of air per hour The concentration is of course very small and does not greatly exceed that found in the best outdoor atmosphere It should be mentioned here that a common mistake made in the installation of ozonizers for ventilating purposes is that too high a concentration of ozone for breathing purposes is produced An excess of ozone in the air is unpleasant to many people and while it cannot be considered dangerous still there is a possibility of producing temporary discomfort. The concentration best adapted for breathing purposes has been a subject of much discussion and it has been variously given as from 0 001 to 0.5 grammes per cubic meter air For direct breathing a concentration of 0 5 gramme is much too high and would be extremely unpleasant even for only a few minutes. The figure that has been best agreed upon is a concentration just a trifle higher than the natural concentration in the atmospheric air say about two parts ozone in 1 100 000 parts of air or about 0 0012 grammes ozone per cubic meter air A popular instruction for the use of such ozonizers is that there should be enough ozone in the air that its odor is just perceivable at all times Ozonizers giving higher concentrations than 0 01 gram cannot be considered safe, and in using such apparatus particular pains must be taken to have the concentration properly reduced by diffusion

While one is inclined to regard these ozonizers skeptically at first still their benefits in every day life have been proven and demonstrated in many cases by medical authorities As a general means for improving the air and as a deodorizer ozonized air has found no rival and is bound to come into very general use Numerous houses hotels schools, theaters and restaurants and especially abroad the leading establishments of this kind have been equipped with them and the reports on their effectiveness are generally very gratifying

Miscellaneous Applications—The industrial applications other than for water purification and ventilation are manifold What I have said about manufacture ventilation and water purification will give you a fair idea of the possibilities along different lines and I have perhaps treated these two applications at greater length than their relation to chemical engineering demands

For reasons previously explained the use of ozone as an oxidizing agent in purely chemical industries has not yet been recognized to any great extent. Since however it has been possible to obtain concentrations up to 30 grammes of ozone per cubic meter of air which corresponds to two per cent of volume by means of a comparatively simple apparatus many possibilities present themselves of using ozonized air for oxidization process especially in cases where it is desirable that no foreign elemeht be introduced into the reaction

By virtue of its gaseous condition and its powerful oxidizing qualities ozone is an ideal gas for sterilizing and disinfecting purposes Like all strong oxidizers ozone is destructive to animal and vegetable life of the lowest order while to animals of higher order and to human beings it is comparatively harmless There are several installations that are being experimented with in order to test the efficiency of ozone as a disinfectant one being for example at the quarantine station at New York and another one at the Pittsburgh Homeopathic Hospital Judging from the results obtained in sterilizing rooms bandages laundry and surgical instruments in hospitals it is believed that ozone will ultimately supplant formaldehyde in disinfecting rooms and buildings The concentration used for disinfecting and sterilizing purposes is of course rather high and should not be less than 5 grams and preferably as high as 10 grams per cubic meter air The sterilization of sewage is a problem which we will be confronted with in the near future in order to avoid the increasing pollution of our rivers and lakes and will be a very fruitful subject for ozone some day and one in which it will have to show its full worth Very considerable concentrations are required for this purpose and 10 to 20 grammes per cubic meter air will be none too high

The uses of ozonized air in medicine are many but it is not within the scope of this paper to discuss them Let it be mentioned that it has been used successfully for inhalation in cases of anemia nervousness insomnia and pulmonary diseases or for local application in the treatment of skin diseases can cerous growths in obstetrics etc

One of the largest fields for ozone in the future is the preservation of food products Experiments have shown that milk cream and butter can be completely sterilized and therefore kept from fermentation and souring for a considerable period of time eggs when stored in an atmosphere of ozonized air will keep for months without apparent change the effect on fruit is still more striking as ozone prevents the molding which starts on the outside of the skin In storing meat products it has been found that refrigeration is greatly helped if the air in the storage rooms is ozonized and that the temperature of the refrigerating room or chamber can be considerably higher in the presence of ozonised air than under ordinary conditions As a preservative, ozone is also destined to meet with considerable use, supplanting drugs, sugar and sterilization by heat.

The apparatus necessary in the applications of ozone is very simple It is illustrated in Fig. 8 and consists of the drying bottle or tank, containing sulphuric acid calcium chloride or lime the fan, blower, or air pump necessary to circulate the air through the ozoniser and the ozonizer proper containing the step-up transformer For experimental purposes it is usual to have a rough testing outfit in connection with the apparatus, consisting of an absorbing bottle for the potassium iodide solution, an aspirator to draw in from the main tube and measure the volume of air passing through the absorbing solution, and a gas meter in the main line, by means of which the total volume of air ozonized can be measured.

Considerable success has been achieved by the use of ozonized air in order to prevent the growth of parasites, as for example, in the storage of flour and flour products, to prevent molding It has also been applied in many cases, especially in England and Belgium, to the fermenting cellars of breweries, where it prevents the growth of parasites and still has no retarding effect on the fermenting process The number of living bacteria in those cellars is said to be thereby also greatly reduced, and it is generally found that those which are not directly killed are not capable of reproduction

Concentration of about 0 5 gramme ozone per cubic meter air is usually adapted for this purpose Besides this a number of breweries have adopted the ozone system for the purification of their water

In the case of the manufacture of wines and liquors ozone is being used to a large extent in France for the purpose of destroying the empyreumatical odor and oxidizing the fusel oils in products which have not been sufficiently aged The action of ozone in this case is said to be identical to the action of aging and it is reported that wines and liquors are produced in France in from three to twelve months which cannot be distinguished from similar products which have been aging for from two to ten years Ozonized air is also largely used for sterilizing casks and other implements used by producers of wines and liquors

The bleaching and deodorizing properties of ozone have been recognized early and are now being utilized to a considerable extent in the case of fats greases, and oils of mineral, vegetable and animal origin Vegetable oils for example are not only bleached and discolored but also thickened and in the case of animal products like tallow grease and fats, ozone has been found a valuable means of improving appearance and quality Rancid and other offensive odors can be entirely removed and it is possible in this way to considerably reduce the amount of waste

In the case of sugars, as well as flour and starch ozonized air has been found to accomplish bleaching very satisfactorily Its bleaching effect is superior to even that of chlorine and is all the more striking as it not only bleaches but destroys diseased parts and kills parasites which feed upon such products There are hundreds of other applications of ozone in bleaching such as for example delicate processes like bleaching of ostrich feathers and fine fabrics In ordinary laundry work ozone surpasses the effect of bleaching chemicals and has the additional advantage of sterilizing the fabrics without injuring the strength and flexibility of the fiber such as the bleaching agents generally used for this purpose do The bleaching of wood pulp is also one of the future fields for ozone As to the concentration of ozonized air which is employed for bleaching it is evident that it should be as high as possible and an average of 8 grammes per cubic meter air is none too high

There are a number of purely chemical uses for ozone, and it is safe to predict that as an oxidizing agent it will come into much more general use in chemical manufacturing and research work than it is at present. As an example I call attention to the use of ozone in the production of artificial camphor in the synthesis of rubber and the large field it will have in the future in the manufacture of perfumes

The metallurgical industry has started to make quite an extensive use of ozone in the cyanide process of extracting gold and it is claimed that the yield has been increased from 60 per cent to over 90 per cent by means of ozonized air

A field for ozone which has not as yet been exploited but which is bound to become important in the future is the sterilization of the water for refrigeration. Ice made from water which has previously been purified with ozone is perfectly clear and sterile, and will ultimately fill a long felt want in this direction

As a deodorizer there is no substance which can anywhere equal ozone and it is possible by means of it to remove in an incredibly short time offensive odors in storage rooms, glue and leather factories, and in other establishments noted for their disagreeable odors.

The outline which I have given here of the accomplishments and possibilities in this new field should serve the purpose of calling attention to and awakening an interest in a remarkable product which for general usefulness is surpassed by very few of the thousands of substances known to chemistry There is no special branch of the chemical industry where ozone cannot in some manner or other fill a want, and I believe that there are few, if any members of this Institute present who will not find it to the interest of the industry they represent to further investigate the subject.

The Generation of Power*

The Enormous Development of the Energy Stored by Nature

By D. S. Jacobus, E.D.

No art has developed within the last few years at a more rapid pace than that of the generation of power. This development has been in the line both of an enormous increase in the amount of power produced and in the economy with which it is generated. With this have come developments in the electrical field, and so closely are the two related that the unit of measurement of efficiency of our power plants is usually expressed electrically, that is, in the cost required to generate one kilowatt of electrical energy per hour, or the amount of fuel or its equivalent heat value required to generate a kilowatt hour.

The great advance in artificial illumination brought about by the electric light, the establishment and extension of trolley lines for city and interurban service, and the distribution of power to both small and large consumers have heavily taxed the resources of our central power plants, which have been continually increased in capacity to meet the demands. So rapid has been the advance that what was the best practice but a few years ago is in most cases not the best practice of to-day, and it is no rare occurrence to see equipments which were up to date less than ten years ago replaced by something better. The development of the steam turbine has had much to do with this—a development which has proceeded so rapidly that it must be regarded as one of the marvels of engineering.

Steam is to-day the ruling power. Hand in hand with steam come the gas-engine and hydraulic power developments. Each has its own particular field, and any individual case must be considered by itself before it is possible to say which form of power will be the most economical. Of these three methods of generating power the hydraulic surely has the advantage as far as the conservation of our natural resources is concerned, but history has shown that the development of most water powers is simply a preliminary step to the installation of an auxiliary steam plant to insure continuity of service, and in many cases the power demands become such that the steam plant is eventually the more important of the two. What follows will bear more especially on the production of power by steam.

We often hear the cry that we are a wasteful people, and that we should save our coal deposits and make more use of such natural powers as the wind and the waves. These methods of producing power, especially in the case of the wind, have filled particular needs, but as a means of generating the large quantities of power now used for industrial purposes they would be completely inadequate. For example, let us consider the power generated by a single steam turbine of 20 000 kilowatts capacity. To produce this power with windmills each having wheels 25 feet in diameter, and with a wind velocity of 20 miles per hour, we would need over 6 000 windmills, and if the mills were placed 50 feet apart they would form a line about 60 miles long.

Again, let us compare the power obtained from the steam turbine with that available from a wave motor. If we should construct a wave motor which would convert half of the total energy contained in the waves into electrical current, and which would be operated by a continuous series of waves 200 feet long and 4 feet high, it would have to extend along the coast for a distance of about a mile and a third to give as much power as the single steam turbine. The cumbersomeness and cost of constructing such a wave motor would render it impracticable, whereas for certain uses where smaller amounts of power are needed a wave motor might be developed to serve the purpose.

Let us consider animal power. A horse develops, say, three-quarters of a steam-engine horse-power under favorable conditions, which means that about 35,000 horses would be required to do the work of the single 20,000-kilowatt steam turbine.

The consideration of the subject from a theoretical standpoint is most interesting. The steam engine is handicapped in its efficiency as compared with the gas engine by the lower initial temperature of the working fluid in the cylinder, whereas the gas engine is handicapped as compared with the steam engine by not being able to make use of a low temperature at the end of the cycle. In a steam engine a great part of the work is done by the steam at a pressure below the atmosphere, every degree that the condensing water is lowered being available for increasing the work and representing the lower limit of temperature. The steam turbine is especially adaptable for utilizing the low temperature at the end of the cycle. In a gas engine the lower limit of temperature is that of the hot gases at the end of expansion, a temperature usually higher than the initial temperature of the working fluid in a steam engine.

The question is often asked why a good arrangement could not be obtained by combining a low pressure steam turbine and a gas engine so as to secure the benefits of the high initial temperature in the gas engine and the low final temperature in the steam engine. On working out an actual example, however, it will be found that the work of the steam turbine would be comparatively small, amounting to less than 10 per cent of that of the gas engine, so that the installation of the steam turbine would not as a rule increase the capacity or efficiency enough to warrant the additional expense and complication of the plant.

Many so-called new cycles for the production of power have been brought out from time to time. In most cases these cycles serve as an illustration of the old adage that a little knowledge is a dangerous thing. The inventors often work out pages of thermodynamic formulæ to uphold their views. In other cases the problem is dealt with in broad generalities, heat units being handled as if they were packages that could be moved at will from shelf to shelf, and so made to pass from one part of the apparatus to the other without loss, no consideration being given to the amount of surface required to effect the transmission or to the radiation losses. In some cases heat is assumed to be transferred from one part of the cycle to the other, no proof being offered that the interchange will be possible, that is, from a hotter to a colder medium. Still other inventors actually build machines only to find that this is the most expensive way of becoming convinced that they are mistaken. I have had to examine many such schemes, and in most cases it could be readily shown that the cycle was at variance with the well known laws. Cycles that do not conflict with the laws can usually be shown to be impracticable when the sizes of the parts necessary for an actual machine are computed and the radiation losses allowed for. If we could but find a way of disposing of heat at a temperature lower than that of the surrounding objects, we could utilize all of the heat of the ocean or the atmosphere to develop power. Many of the schemes advanced in the so-called new cycles are equivalent to this, and the inventors have wasted their energies in striving for the impossible.

Much depends on the load curve of a power plant in obtaining economy. If a continuous uniform load could be carried, many of the vexing problems which confront the power plant engineer would be eliminated. It is difficult to carry economically enough reserve capacity to meet the daily peaks in the load. Then again there are exceptional peaks which occur only at rare intervals, so that a considerable percentage of the available power may be developed only for a few hours every month, or for that matter for a few hours every year. Modern practice leads more and more to developing higher ratings from boilers during such intervals, and a boiler should be used which under proper operating conditions may be driven to a capacity that is limited only by the amount of coal which can be burned in the furnace. Again, it is desirable to use boilers that may be cut into the line quickly, either from banked fires or starting from a cold state.

The practice in this respect is exemplified by considering the installations of the Commonwealth Edison Company at Chicago, where the first 5 000 kilowatt turbines erected in this country were installed. This was in 1903, and eight boilers, each having about 5 000 square feet of heating surface, were supplied for running a turbine. The maximum rating for these turbines was 7 500 kilowatts. Later on 12 000 kilowatt maximum rating turbines were installed, each with eight boilers of the same size as provided for the 5 000-kilowatt machines. Still later machines of 14 000 kilowatt maximum were run with the same size and number of boilers as the original machines of 7 500 kilowatt maximum.

The steam pressure in power plants of this country is usually about 185 pounds to 200 pounds per square inch, and about 150 deg. of superheat is carried. The economy of superheat in this work is well established and represents the best practice.

The steam turbine is becoming more and more the standard for large power-plant work, both on account of its fuel economy and the low cost of attendance. The most economical fuel consumption under operating conditions that has so far been published was obtained in a test with piston engines, where a kilowatt hour was turned out of the station for each 25 000 B.t.u. contained in the fuel. The station referred to is the Redondo plant of the Pacific Light and Power Company of California, and the results of the test, at which I was fortunate enough to be present, were given by the designer of the plant in a paper published in the Transactions of the American Society of Mechanical Engineers for 1908. The fuel was California crude oil. The load curve had two high peaks, and the entire plant was shut down during a lay-over period of four and a half hours per day. The 25 000 B.t.u. represent the heat of combustion of the oil used per kilowatt hour net electrical output for the entire fifteen-day period during which the test was run. It is a fact worthy of note that this result approaches that to be expected for the plant economy of large gas engines for the class of service considered, where the power is variable and reductions must necessarily be made for all the auxiliaries, etc.

While no results for plant economy as good as the above have been published for steam turbines, it is only fair to say that the figures for steam consumption for turbines show that better than this economy can be obtained under uniform load conditions. When it comes to plant economy so much depends on the load conditions that it is hard to compare one plant directly with another.

We have in this country many large power plants. In New York we have the Edison Waterside stations and the Interborough station; in Boston the Boston Edison Company's station; and in Chicago the Commonwealth Edison Company's stations, two of which, built near each other at Fisk and at Quarry Streets, have an aggregate maximum capacity of over 200 000 kilowatts. *It is noteworthy that the first 5 000 kilowatt turbines installed in this country*, which have already been referred to, were placed in the Fisk Street station about seven years ago. The rapid development in the art is exemplified by the fact that these turbines are now replaced by others, although at the time they were installed they represented the latest advance in power plant practice.

The growth in the consumption of power has been so enormous that the question is often asked, Where will it stop? What is a luxury to-day becomes a necessity to-morrow. Where our grandfathers used the tallow dip and oil lamps, we must now have a flood of light rivaling that of the sun itself. Our streets are illuminated in a way that our forefathers would have considered impossible, and no one would wish to go back to the darkness that would tempt the highwayman and render travel difficult. Ventilating fans are now regarded as a necessity, and electrical current is used for a number of household purposes. We could not indeed go back to the old days without giving up many comforts. But where will this great increase in the demands on nature's coal pile land us? This we will have to leave to others to answer. Let us stop for a moment, however, and compare what we are doing with that great silent source of heat and power, sunshine. The sun shining on the world for a single minute imparts as much heat as that contained in all the coal and oil produced in our country in a year, and when we make this comparison we cannot help but appreciate the littleness of our endeavors and have confidence in the great recuperating powers of nature.

* The Journal of the Franklin Institute.

Economy in Meat Production

At a recent meeting of the French Agricultural Society a paper was read by Messrs. Gouin and Andouard, discussing the influence of the age at which cattle are slaughtered upon the production of meat. It has been stated by some that the present scarcity of meat in France is due to the method in vogue of slaughtering animals before they have reached complete development. The authors consider that this is an error, and that stock should be utilized as soon as the flesh has attained its value as meat for the table, this being to the advantage both of producer and consumer. The total amount of hay fed to three animals up to the age of 3½ years is 33 long tons. This would suffice for seven animals up to the end of the second year. But the yield in meat from the seven young animals is 10 per cent in excess of that from the three adults. Thus with the same amount of food material the stock raiser can put much larger quantities of meat on the market by rapidly renewing his stock.

The Bergen-Christiania Railway

A Recently Completed Scandinavian Line

By the English Correspondent of the Scientific American

One of the most important railway enterprises which has been completed in Europe within recent years is the trunk standard gage line that has been recently opened across the Scandinavian peninsula for the purpose of providing direct communication between Bergen on the Atlantic seaboard with Christiania. The necessity for such a link has been sorely experienced for many years past, but the engineering difficulties confronting the scheme were of such a stupendous character as to prevent its earlier realization.

The line was first projected in 1870 and was estimated to be about 320 miles in length. It was realized from the first that construction would be difficult inasmuch as the mountains to be negotiated rise very abruptly from the sea and the interior plateau is storm swept throughout the whole year. However two engineers were selected to ascertain its feasibility. Their report was of such a favorable nature as to induce the authorities to sanction the first part of the scheme which entailed the building of a meter gage line from the sea to Vossangen at the foot of the mountain range a distance of about 67½ miles. The work was commenced forthwith, and was opened for traffic in 1883.

The extension of the line eastward was not abandoned but the main difficulty was to find an easy passage through the mountains. This was a difficult matter as the range is so broken up. The engineers made several preliminary surveys and elaborated several routes but in any case extensive tunneling would be requisite. These preparations occupied eleven years and it was not until 1894 that the actual extension was sanctioned. Even then the authorities only decided to proceed as far as Taugevandet 114 miles from Bergen leaving the further extension open for the time being.

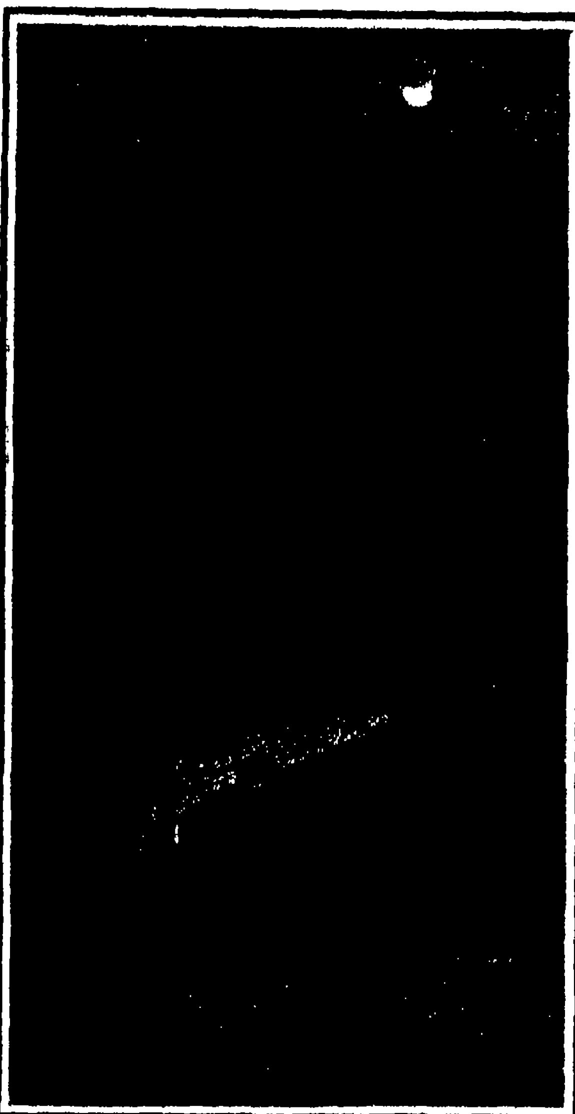
The engineers pointed out that owing to the range dropping so precipitously into the sea with an absence of wide valleys the line would have to rise to a great altitude to secure a favorable grade. They also emphasized the fact that owing to the exposed nature of the interior table land rain and snow would also remain a serious problem. The snow in particular was a sore question and to gather reliable data concerning its fall drift, and so forth several meteorological stations were set up in 1884 and daily observations made. These revealed a rather remarkable state of affairs it being found that snow fell every month during the year and that the average fall during the winter was 11 feet deep. Its movement was also extraordinary owing to the severity of the winds which caught the soft dry snow and piled it into drifts which formed as much as 16½ feet deep. Even in the month of August in the sheltered places, drifts were found over 3 000 feet in length by 5 feet deep.

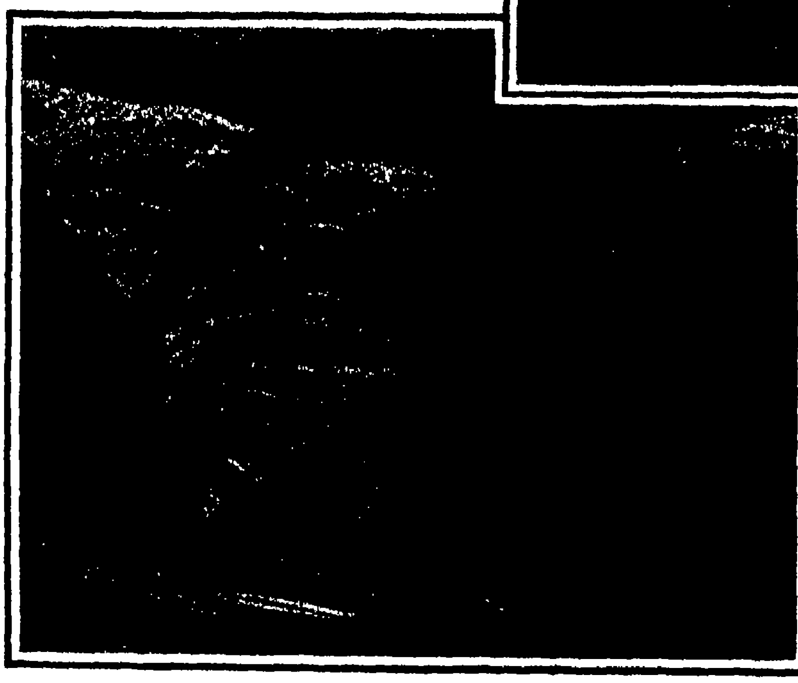
These observations sufficed to demonstrate that constructional work would be arduous and difficult and also that extreme precautions would have to be observed to keep the line open and to mitigate the evil consequences of the drifting movement by means of extensive defenses in the form of wooden screens. In all nine routes were drawn up and submitted to Parliament. The outstanding feature of these routes was the means of penetrating the range from the coast side. A tunnel could not be avoided, and the most feasible route was one involving the boring of twelve tunnels aggregating 11¼ miles in length in the total distance of 47¼ miles through the range from Voss to the summit of Taugevandet. The most formidable was the Gravehals tunnel, 17,490 feet in length. The steep grades and sharp curves which were necessary to preserve alignment were also vital factors.

The government, however accepted the Gravehals tunnel route. After leaving Voss the line commences its ascent of the range immediately, rising from 150 feet above sea level to the Taugevandet summit at 4,350 feet. The Gravehals tunnel which is the longest work of its kind in northern Europe, has its western entrance at about 95½ miles from Bergen, at an elevation of 2,818 feet above sea level. From the Bergen portal the tunnel has a grade of 5 per cent for some distance, followed by a stretch of 3 per cent to its highest point, where there is a dead level stretch 590 feet long, followed by first a 3 per cent, and then a 5 per cent downward grade to the eastern portal the drop continuing until Myrdalen, approximately 109 miles from Bergen, where 2,839 feet altitude is reached.

Owing to the timber line in this district being at 2 460 feet altitude, so that the tunnel portals are fully exposed to wind and weather its construction was an exacting task. Boring was carried out from both ends, the contract price being $808 000 complete. For the supply of electric energy the Kjos Fall was harnessed and the current transmitted to the two ends of the tunnel the aggregate of the water turbines on the west end being 280 horse-power. On this side two Brandt boring machines working at an average pressure of 80 atmospheres were used together with four Frölich and Klüpfel pneumatic boring machines as the former system could not be used for the full section. On the eastern side hand boring was resorted to. The estimated rate of progress was 197 feet per month on the west and 50 feet per month on the east side, respectively. The results of the first year's working however were so far below the estimated progress owing to the extreme hardness of the rock that the contractors had to improve their methods in order to be able to keep to the contracted time for completion. Accordingly on the east side hand boring was first superseded by electric boring machines driven by a small petroleum motor, but being unsatisfactory were discarded in favor of pneumatic appliances with which such advance was made that the two headings met two months before the contract time. The tunnel however was not completed for nearly two years later which delay however exercised no significance inasmuch as the adjoining sections of track were behind owing to the scarcity of labor.

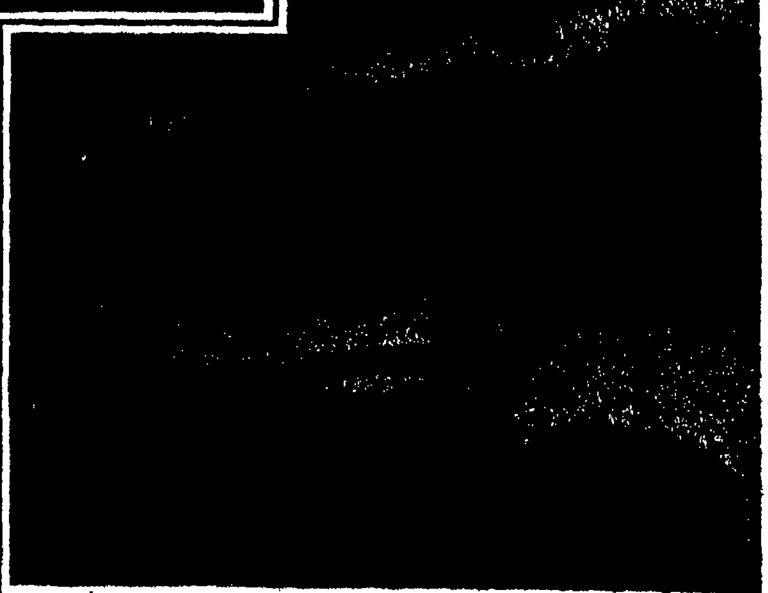
This latter factor proved a difficult problem. The works were far from civilization and owing to the exposed position of the site the privations were so severe that men refused to be attracted to the spot, especially as they could secure plenty of work at the same wages in more congenial centers. The conditions under which the tunnel was driven were certainly unique. Once work had to be suspended for some six weeks owing to an avalance crashing into the power house on the west side, and carrying half of it away. On another occasion a stoppage of two months' duration became imperative, as no water was obtainable, while the extreme severity of the





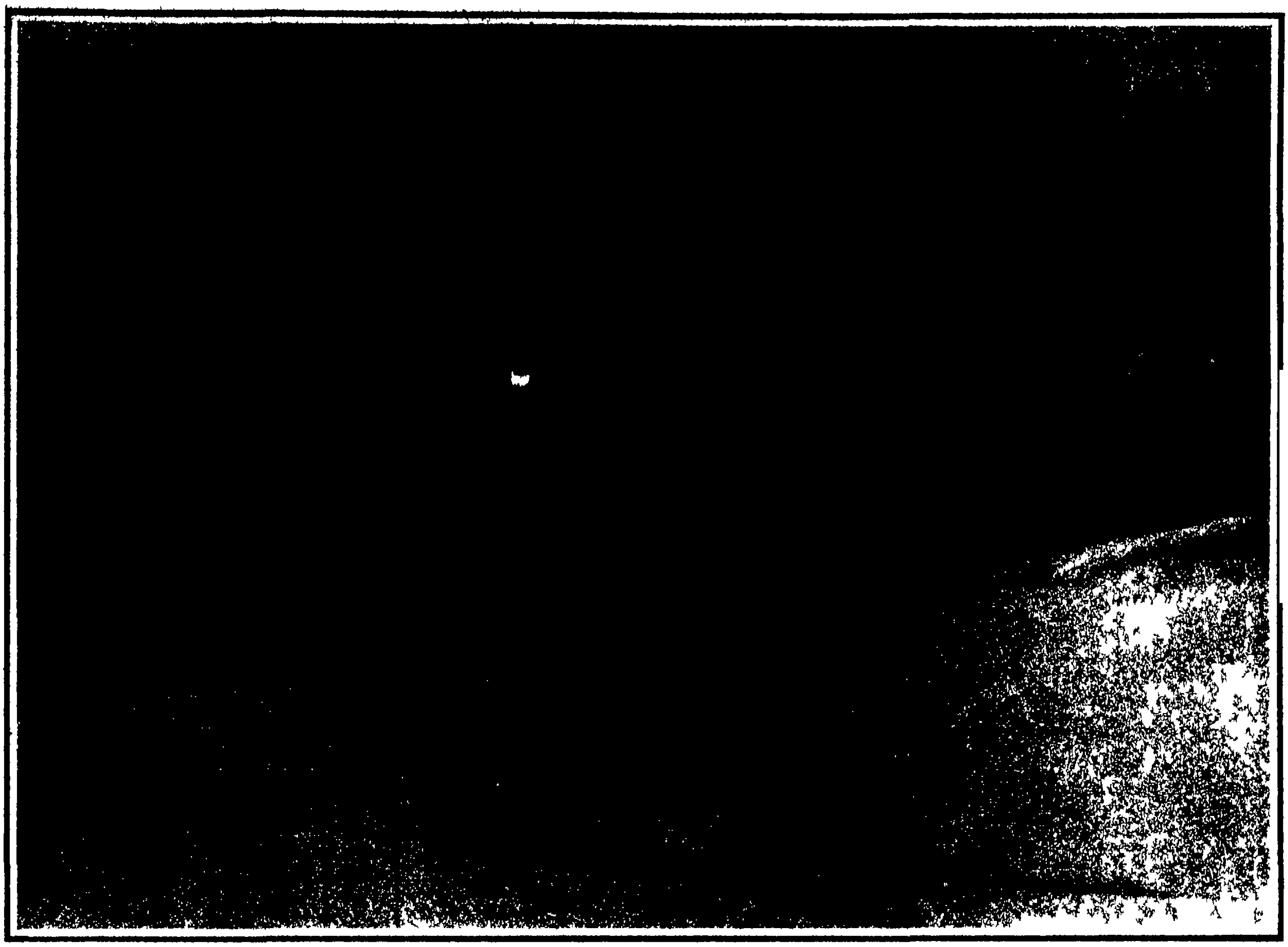
THE FLAAMS VALLEY THROUGH WHICH THE BERGEN RAILWAY RUNS SHOWING DEFILE NATURE OF VALLEY

TRAIN EMERGING FROM REINUNGA TUNNEL WITH SNOW SCOOP ON LOCOMOTIVE



MYRDALEN STATION SHOWING ENTRANCE TO GRAVEHALS TUNNEL, 17,490 FEET LONG

THE BERGEN CHRISTIANIA RAILWAY



BERGEN RAILWAY NEAR VATNAHALSEN VIEW SHOWING CHARACTER OF COUNTRY TRAVERSED THE GRADE IS HIGH ON THE HILLSIDE

WINTER VIEW OF MYRDALEN STATION ON THE BERGEN CHRISTIANIA RAILWAY

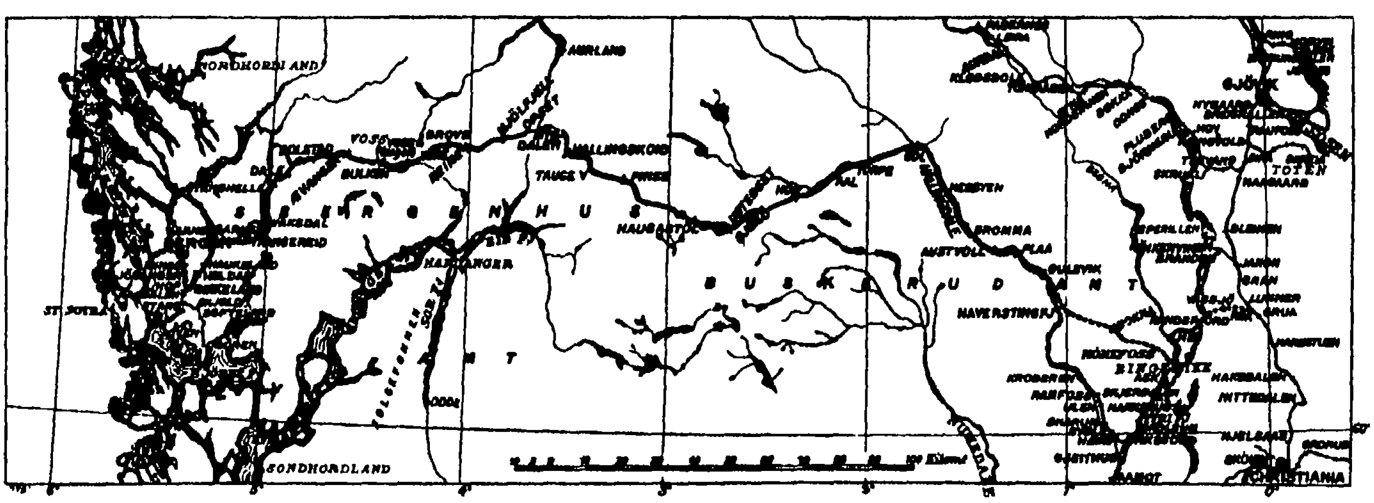
THE BERGEN-CHRISTIANIA RAILWAY

climate was also another deterrent factor in rapid construction

After issuing from the Gravehals tunnel the line commences another ascent rising 1 411 feet to gain the summit at Taugevandet 14 miles beyond Myrdalen When the line has traversed 1¼ miles east of the Gravehals tunnel the grade being located high on the mountain side another long tunnel the Reinunga is entered This is the second most important work of this class on the line system being 5 217 feet in length and with a continuous grade against east bound traffic of one per cent for the whole of its length This tunnel was bored throughout with electric boring machines the current for which was secured from the power station on the east side of the Gravehals undertaking where 100 horsepower was set aside for this purpose

In June 1898 while work on this section was in progress the government decided that the line should extend eastward from Taugevandet via Gulsvik and Roa where it was to be linked up with the existing eastern railway system After leaving Taugevandet the descent immediately commences and the grade is much easier than that on the western mountain slopes the total drop between Taugevandet and Haugastol 23½ miles farther on being approximately 950 feet The country is then gently undulating for a short distance when there comes another sudden descent to Aal at 169 miles from Bergen at an altitude of about 1 414 feet On the eastern slopes of the mountains owing to the valleys being wider the alignment of the line was appreciably facilitated The descent still continues until at Bromma 205 miles east of Bergen it is at an altitude of about 400 feet

The grade is gently undulating onwards to Gulsvik after which is another slight ascent to overcome the foothill range which is pierced at Haversting at



MAP OF THE SCANDINAVIAN PENINSULA ACROSS WHICH RUNS THE BERGEN-CHRISTIANIA RAILWAY

THE BERGEN-CHRISTIANIA RAILWAY

an altitude of 460 feet by a tunnel 7 644 feet in length which owing to the hardness of the rock proved a difficult undertaking work being carried out first on time then by contract and finally by piece work in order to accelerate progress Issuing from the tunnel the descent is effected with easy grades to mile 262½ when another sharp climb becomes necessary from 300 feet to 1 000 feet through Vassjö and an immediate equally steep descent into Roa where a junction with the eastern railway system leading into Christiania is effected The total length of the line from Bergen to the capital is approximately 306 miles

Altogether there are no less than 184 tunnels on the line representing a total length of about 24 miles The constructional work entailed the excavation of nearly 35 500 000 cubic feet of earth and 28 000 000 cubic feet of rock on the high mountain section while the consumption of dynamite for blasting ran into 1 540 000 pounds There are 57 stations between the two terminal points and owing to the later extension of the line eastward from Voss being of standard gage that between Voss and Bergen had to be altered from the meter gage to secure uniformity In addition to the tunnels there are fourteen large bridges the largest three of which are in masonry one having a span of 150 feet and another being 566 feet in length with eight 70-foot spans Owing to the exposed nature of the line in the upper sections above the timber line extensive fencing as a defense against drifting snow was necessary beside the track these screens being almost continuous for 60 miles between Mjolfjeld and Gjeilo The line passes through a wilder stretch of country than any other European railway The winter lasts nine months, and sometimes longer the snowfall is heavy and the rain storms terrific with a tremendous downpour The line cost about $15,800 000 to build, and the difficulties of construction are only equaled by those experienced in keeping it open for traffic Three American rotary plows are used in winter and one is always kept ready for service as it has to be requisitioned on one or more occasions every month during the year and a heavy snow block in midsummer is by no means a rare occurrence The provision of the line however has reduced the time of transit between Bergen and Christiania from 54 to 14 hours, and is an important highway for traffic Numerous extensions are already projected with a view to bringing the eastern and the western industrial centers into closer communication

Expiration of the Bradley Patents and the Manufacture of Aluminium

The patents covering the fundamental processes for the electrolytic separation of aluminium as originated by C M Hall expired some years back December 8th, 1908 and February 2nd 1909, marked the expiration of C S Bradley's patents for a continuous process. It is thus perhaps an opportune moment to give some attention to the general subject

Chemical and geological investigations disclose the fact that so far as the terrestrial crust is concerned aluminium is the third most abundant substance Yet aluminium is not cheap How then is expensiveness to be reconciled with abundance? About 1885 aluminium was worth approximately $12 per pound The great fact which makes the apparently contradictory one consistent is that aluminium has been exceedingly difficult to isolate from its compounds But in combination with other elements it forms so it has been calculated 7 81 per cent of the materials accessible to us Its price to-day is quite low comparatively to what it has been so that it is coming into large use in industrial applications

Aluminium was first isolated in 1827, but its form was then only that of a powder and this powder could not at that time be melted into a coherent mass In deed it was not quite pure A quarter of a century later (1854) Deville succeeded in obtaining it in a form which could be melted without oxidation In the early part of 1856 aluminium is said to have been worth about $90 per pound but by autumn it had suffered a decline of 70 per cent Three years later the price was about $12 per pound At this point it remained until about 1886 In 1887 it fell to $8 in 1888 to $4 84 The following year when Hall's fundamental patents were issued the price tumbled to $2 During recent years it has been merely a fraction of a dollar Up to about 1856 there had been produced a total of perhaps something over a hundred pounds At present it is manufactured in thousands of tons annually In nature aluminium occurs as a more or less pure oxide in the form of corundum sapphire ruby and emery But the ores from which it is now commercially obtained are chiefly bauxite and cryolite

While still in his twenties Hall sought and found a method by which aluminium could be obtained electrolytically In the successful application of electrolysis use is made not of an aqueous solution of the aluminium but of an anhydrous one He found that a bath consisting of a mixture of a fluoride of aluminium and of a metal more electro-positive than aluminium (as sodium etc) would when at a sufficiently high temperature dissolve the oxide of aluminium (alumina) Two electrodes are now introduced into this heated mass and an electric current of proper electromotive force is started At the positive electrode, oxygen will be given off, at the negative electrode, aluminium is released Now it will readily be understood that, in practically carrying out this procedure, it would be necessary to maintain the heat of the bath Hall's patent (No. 400,766) specifies the use of a suitable furnace. The vessel containing the bath might be of iron or steel This could be lined with carbon. The lining would then, so the inventor states, serve the double purpose of protecting the metal vessel and of acting as one of the electrodes He suggests the use of the mineral cryolite and of the fluoride of aluminium, in proper proportions, as the proper constituents of the solvent. The aluminium melts and collects in globules on the negative electrode—as the carbon lining—and drops down to the bottom of the crucible The specific gravity of the metal is quite low (about 2 6 when solid), but that of the bath is lower still.

In carrying out this process of Hall in a commercial manner perhaps the most noticeable departure has been in connection with the manner of fusing the materials entering into the bath and of maintaining that fused condition Hall prescribed an external application of heat He probably thought of no other possibility But in practice it has been found desirable to supply heat by means of the same current which effects the electrolytic action A heavy current is needed to perform the double duty At Niagara Falls the Hall process was early carried out in the following way Long carbon-lined iron tanks were provided These constituted the cathodes or negative electrodes With in these tanks the materials for the bath were placed Into the bath a row of carbon electrodes depended from a longitudinal support Thus were secured the positive and negative ends of the circuit A number of these tanks were connected in series The aluminium ore used was bauxite, an hydroxide of aluminium employed to furnish the alumina (Al_2O_3) for the bath Bauxite as found in Georgia and Alabama contains in the neighborhood of 65 or 70 per cent of alumina. In the electrolytic action which takes place the aluminium melts and drops down to the bottom of the tank the oxygen set free from the alumina it has been said attacks the carbon of the anodes and forms carbon monoxide The chemical equation for this reaction is

$$Al_2O_3 + 3C = 2Al + 3CO$$

As this gas rises to the surface of the heated bath it burns to carbon dioxide The formation of the carbon monoxide (CO) at the anodes involves the consumption of carbon at that point. So it was found necessary to lower the line of anodes into the bath as time went on

The ore which Bradley seems to have had particularly in mind was cryolite the double fluoride of aluminium and sodium found on the coast of Greenland However the Greenland ore contains only about 13 per cent of aluminium Its use is attended with the disengagement of an impure fluoride gas. With bauxite on the contrary the disengaged or resulting gas is only carbon dioxide which may be discharged into the open without ill effects

One may wonder why it has seemed desirable to get away from the use of external heating It was found that action on the crucible both from within and from without resulted in rapid deterioration.

The modification of the original process of Hall which eliminated the external method of heating the bath seems to have been due to C S. Bradley The broader of his two patents appears to be No 468,148 which was issued February 2nd 1892 Let us consider the process as here disclosed. In a pile of the materials in pulverised form from which the aluminium is to be electrolytically derived a cavity is made at the summit To begin operations two electrodes are first brought into contact, a suitable current having been turned on and an arc formed The electrodes with the arc between them are now pushed down into the heap The materials in the immediate vicinity of the arc are fused Since the fused material forms a fair conductor, the arc now ceases But the fused condition is maintained because of the electrical resistance to the passage of the current The aluminium is set free at the negative electrode, and drops to the bottom of

the fused mass. Fresh material is added as the process goes on. There is here no tank at all, the unfused portion of the material serving the purpose However this material may be confined in a holder protected by the unfused material Again the pile of material may be placed on a carbon slab which together with a small carbon forms the negative electrode To begin operations, the arc is developed between the large and small carbons as before When the action has proceeded far enough to provide a fused mass between the slab and the positive electrode the small carbon may be withdrawn

Scientific Error and Gas Engine Design

Necessary Reversals of Former Engineering Opinion

RAPID as has been the development of the internal combustion engine in comparison with that of other prime movers it is worth considering whether progress might not have been even faster had it not been for certain widespread misconceptions as to its scientific basis The history—short as it is—of the internal combustion engine contains several instances in which for a period of some years the most powerful authorities on the subject were urging the acceptance of incorrect theories and were drawing quite wrong deductions from the practical observations they made As it is proverbially easy to be wise after the event so it is now easy to see the many grave errors and mistakes that were made and to realize in addition how with a slightly fuller consideration of the matter they could have been avoided

The two chief directions in which a reversal in the generally received opinion has been found necessary are those briefly denoted by the terms stratification and gaseous specific heats The former of these unfortunate misconceptions had a great influence on the development of the gas engine The idea underlying it was introduced by the German engineer Otto in the year 1876 when he patented his famous engine His idea was to increase efficiency so that the then very high rate of gas consumption should be reduced to a more economic figure and that the noise and vibration due to the running of such plant which was so undesirable a feature of its operation should be minimized To bring this about he altered the way in which the charges of air and gas were admitted to the cylinder His plan was first to admit air then a poor mixture and finally a rich one Furthermore he was careful to keep in the cylinder a portion of the burnt products of the previous explosion This he claimed had the effect of arranging in layers —or stratifying - the different kinds of gases and gaseous mixtures Next to the cylinder there was to be a layer of burnt products then a layer of pure air then a layer of a weak mixture and finally a layer of mixture of full strength This laminated mixture was to be ignited at its richest point and the flame was to proceed from layer to layer this it was argued would have two benefits—the provision of a cushion or buffer between the explosion and the piston and the lengthening of the time of combustion to a period approaching that of the whole stroke In point of fact these deductions were not correct The charge as it comes into a gas engine cylinder does not stratify and any part of the gaseous substance would act—or fail to act—as a buffer equally well Indeed the way in which combustion proceeded throughout the cylinder was not different—in any material way at any rate—from that customary with the gas engines which preceded the Otto patent Although this was so Otto produced an engine which was a great improvement on any of its predecessors and this undoubtedly influenced those who listened to his arguments Even men like Slaby Dewar and Bramwell supported his case when the fight over the patents had to be faced and largely as a result of their support the Otto patent was enabled to rule the gas engine industry for fourteen years Once it lapsed all manufacturers eagerly adopted it From this misunderstanding of the principles of the operation of the engine there issued the temporary creation of a monopoly and the consequent compulsion on all other manufacturers to use their ingenuities in the manufacture of less efficient models This error in a proper understanding of the principles of operation greatly hindered the development of the engine

Had it been realized in 1876 that the real merit of Otto's engine was its mechanical perfection coupled with the adoption of "compression the patent could scarcely have been upheld since Beau de Rochas in 1862 had filed a patent laying down in the clearest terms the ideal direction in which gas engines should be developed and had placed great emphasis on the necessity for compressing the charge before igniting it Not only this but in the previous year 1861 Gustave Schmidt in a paper read before the Institution of German Engineers had advocated compression It seems in fact that the idea was much in the air and was seizing the imagination of many workers Nevertheless from 1862 to 1876 no engines were made to work on this principle and the great move forward was left to Otto Although Otto adopted this method he attributed its success to more novel reasons than compression the matter thus became the subject of a patent and others were forbidden to enter the field Otto's idea that combustion continued throughout the stroke stood its ground for a very long time despite all that students of the subject of combustion could say to the contrary Indeed it may be said to have some life still though of a not very vigorous kind It is possible that in special cases combustion may be delayed by the existence of pockets in the cylinder or by skin effects but it is doubtful whether such delay occurs at all in normal circumstances This is however one of the points under investigation at the hands of the Gaseous Explosions Committee of the British Association which was appointed at the Leicester meeting to report upon this and other allied matters Mention of the work of the committee brings us naturally to the consideration of the other of the great fallacies which have blocked the path of progress in the gas engine industry and which the committee has done much to clear up The amount of this blocking' is different both in kind and in degree to that due to the stratification fallacy It has not had the effect of creating a temporary monopoly but it has deprived the gas engine designer of the scientific guidance to which he is entitled to look It is as though a traveler in a little known country should find all the sign posts turned through an angle sometimes large and sometimes small but always unknown A wise traveler in such circumstances would probably pay no attention at all to any of them and this is very much what the gas engine builders have done They ceased to believe that the theory of thermodynamics was going to be of any use in the practical work of engine design The temptation to adopt this attitude became the greater as manufacturers realized earlier than the scientists that there was something wrong with gas engine thermodynamics The common scientific theory taught that gas engines were ideally capable of a much greater increase in thermal efficiency than the manufacturers knew to be possible The reason for this discrepancy was that the scientists worked out efficiencies on the basis of constant specific heats whereas the manufacturers worked with a real substance and not with a dream stuff Theorists taught that the amount of heat contained in the gaseous products in a gas engine was exactly proportional to its temperature whereas in point of fact the amount of heat reckoned from 100 deg C instead of exactly doubling between temperatures of 1 000 deg and 1 900 deg C was really nearer the ratio of 2½ to 1 The difference between 2 and 2½ in these calculations as in most others is very great and renders the old theory inapplicable The suggestion from the scientific side that there was something wrong with the basis of the old theory came from France where two eminent physicists MM Mallard and Le Chatelier measured the specific heat of different gases at various temperatures and found a very marked difference in the values for high and for low temperatures

This idea was not at first received with much cordiality in England and even now the accuracy of the French figures is doubted Still there has been a great shift in the point of view and the Gaseous Explosions Committee which contains representatives of all schools has admitted the reality of the French physicists suggestion as beyond doubt although declining to commit itself to actual figures pending the result of certain experiments now being undertaken notably by Mr Dugald Clerk and by Prof Hopkinson The committee has however given in one of its reports a curve of specific heat which is considered to be accurate within 5 per cent It is not difficult to show by the use of such a curve that a gas engine which was previously thought to be capable ideally of 54 per cent efficiency is really only capable of about 43 per cent when the real nature of the actual working medium is taken into account as naturally it should be This is only one instance but the principle applies to all engines It cannot therefore be thought surprising that gas engine manufacturers should have looked somewhat askance on gas engine thermodynamics Had this grave misconception as to the nature of specific heats not arisen there can be little doubt that the designer would have been able to benefit materially by scientific guidance in a way which the circumstances described made impossible In spite of all difficulties however gas engines are now built for the market which achieve thermal efficiency as high as 80 per cent of the theoretically attainable limit for the cycle upon which they work And it will be interesting to learn later on the corresponding percentage of Mr Humphrey's ingenious gas pump which works on a different cycle to that of most gas engines and should have a higher range of efficiencies within its horizon

As an instance not of the effect of prevalence of error but of a condition of entire ignorance we may refer to the recent work of the Gaseous Explosions Committee in the direction of radiation No one had suspected previously that gaseous radiation played the important part it does in gas engines particularly in those which operate at high temperatures Indeed it has yet to be definitely settled whether the glowing gas is very transparent as Prof Hopkinson says or merely fairly transparent as Prof Callendar says to its own radiation In the former case the phenomenon is volumetric and in the latter it would be partly a surface and partly a volume effect It is now beyond doubt however that the amount of this radiation rises with extreme rapidity once the temperature exceeds a certain amount and this accounts for an important fraction of the considerable heat loss at such temperatures so providing a hitherto unsuspected reason for keeping the temperatures as low as practicable With a rich charge and a high compression it is not easy however to keep the temperature low unless on the cycle followed by the Diesel engine where the fuel is admitted by easy stages instead of all at once

To recapitulate the error of stratification was the means whereby a partial monopoly to manufacture was secured and it prevented the best men not already working for the Otto people from developing their own engines on the lines along which useful progress alone was possible The error in gaseous specific heats which still remains in many books on the subject has put the manufacturer out of sympathy with scientific work as he felt he knew better The existence of this error is now realized but it must be a few years before the new experimental work of the physicists has been sufficiently scrutinized and verified to enable science to venture to give a responsible lead to those who as manufacturers have for so long had to depend on themselves —*The Engineer*

The Mixing of Concrete

THE question as to how much water should be used in mixing concrete has often come up for discussion among engineers in Europe and opinions seem to be divided in this regard The German Concrete Association has been giving this matter its attention for some time past, apropos of the standardizing of concrete testing methods In order to elucidate this point, tests were made by preparing concrete in two different places and by different workmen A great number of samples were then prepared having an aggregate weight of nearly 100 tons. During a period of five years these men put through a series of tests as to resistance to various strains These experiments are now completed and the results have been published Among other results the work carried out at the testing laboratory of the Stuttgart Technical School with samples made at the laboratory itself by the same workmen and under the same conditions showed that for a proper composition of concrete the maximum strength appears to be obtained by using the smallest possible amount of water compatible with the production of a good mixed concrete

However the use of the minimum amount of water requires the great st are and can only be practised by very skillful workmen Otherwise it is to be feared that the concrete will not be homogeneous The conclusion is drawn that in proportion as the workmen are less skilled greater security is given by increasing the amount of water It is also to be noted that other factors enter in here such as the variable humidity of the sand gravel etc variations in the hygrometric state and temperature and others and that these also have an influence on the amount of water needed

Relics of the Spanish Armada

How a Treasure Ship was Located at Tobermory Bay

After keeping them securely hidden from human eyes for three hundred and twenty-two years the waters of Tobermory Bay off the coast of the island of Mull, England, have at last given up some of their treasures in the form of a motley collection of battered and worn relics of no value except to historians and antiquarians, but to them of priceless worth, as they tell the story of the tragic end of the famous Spanish Armada better and more graphically than could pages of histories.

Capt. Burns, the principal wreck officer of the Glasgow Salvage Association, who was in charge of the operations, was untiring in his efforts in bringing these woful remnants of the once splendid Invincible Armada to light again. They were recently placed on exhibition at the Glasgow East End Industrial Exhibition, where they attracted the greatest attention.

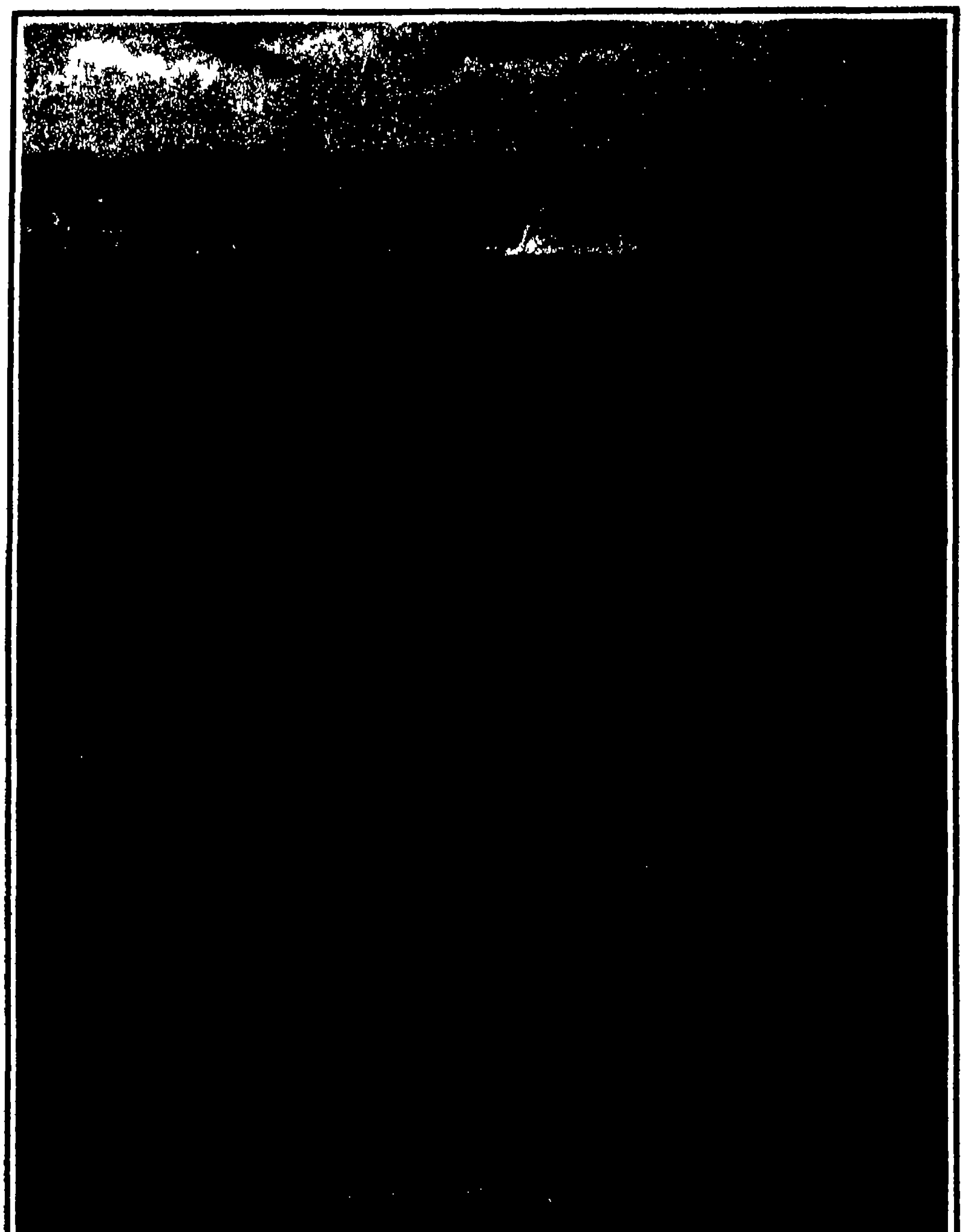
As tangible trophies of deep romantic interest these exhibits clearly prove that tradition did not lie when it said that on the spot where the relics were found by Capt. Burns there was blown up in August, 1588, one of the richest of the ill-fated ships.

It was with the permission of the Duke of Argyll that Capt. Burns pursued his investigations, for since the wreck of this particular vessel was given into the possession of a Marquis of Argyll by royal grant scarcely half a century after the Spanish squadron met its fate off the coast of England and Scotland, the title of that noble family to the ownership of whatever the waters of Tobermory Bay held of the vessel of the Don has been undisputed.

The tradition of this particular bit of the stormy history of England has scarcely changed in a single point in spite of having been handed down from father to son for three centuries, and the recent discovery of the relics has only added to its authenticity. The name of the vessel which was blown up has been spoken of as the "Florida" in old records, but it was really the "Florencia," a Florentine galleon which came from the Levant, one of the Italian possessions of the King of Spain, and was commanded by one Pereija.

By far the fullest account in Scottish history of the loss of this ill-fated ship is to be found in the records of Clan MacLean, whom it most closely concerned. In the year 1588 the chief of the House of Duard was Sir Lauchlane MacLean, who had at that period seriously embroiled himself with his neighbors the Clanranald and the Clan Ian in numerous bloody feuds, and as a result of these had been "denounced rebel" by King James.

Soon after this the "Florencia," commanded by Capt. Don Pereija, was forced by stress of weather and want of provisions into Tobermory Bay. The captain sent peremptory orders to Sir Lauchlane MacLean to supply his ship with such provisions as he might require or as the island could afford. No reply having been made, he threatened to use the means within his power to enforce his request. The haughty chief of MacLean replied to the effect that "the wants of the distressed stranger should be attended to after he had been taught a lesson of more courteous behavior, and in order that he might have such a lesson as speedily as his wants seemed pressing, he was invited to land and supply his wants by the forcible means threatened, for it was not the custom with the chief of MacLean to pay ready attention to the wants of a threatening beggar."



By courtesy of the London Graphic.

THE SEARCH FOR SUNKEN TREASURE AT TOBERMORY: HOW THE SPANISH ARMADA SHIP WAS LOCATED AT BOTTOM OF THE BAY

The search for the Spanish Armada ship which sank in Tobermory Bay, Isle of Mull, in the autumn of 1588. The vessel which has now been found is believed to be the "Florencia," one of the Italian contingent in the Spanish Armada, which is said to have carried thirty million pieces of eight on board. A number of these coins have already been recovered, together with large quantities of black African ... sword hilts, scabbards, muskets and stilettos. The "Pieces-of-Eight" Syndicate, which is now conducting the search for the sunken treasure, has carried on operations since August, 1910, with divers, a borer similar to that ... and a powerful suction plant, all of which may be seen at work in the engraving.

The Spanish commander very discreetly decided to decline the invitation and now promised payment for whatever necessaries in the way of food and clothing might be supplied him. Finally a sort of friendship sprang up between the Don and his Highland host, and in return for the provisions supplied him he offered Sir Lauchlane the assistance of a hundred of his marines, and with this help the Scot proceeded to make war on his neighbors. He first ravaged the islands of Rum and Eig, then held by the Clanranald, and the islands of Canna and Muck, the property of the Clan Ian. After devastating these he made a descent upon the mainland of Ardnamurchan, and, still with his Spanish contingent, laid siege to MacIan's castle of Mingarry.

In a word, he swept through the neighborhood with fire and sword, working havoc wherever he went.

While he was engaged in this way he received a message from Capt. Pereija requesting that the Spanish soldiers be sent back at once, as he was preparing for sea. At the same time he heard that the provisions supplied to the Spaniard had not been paid for. Sir Lauchlane remonstrated with the Don for his injustice, and full satisfaction was promised. On the strength of this the men were sent back, but MacLean, not relying entirely on the captain's promise, retained three of the soldiers as hostages till the debt should be paid. At the same time he sent one of his own men, Donald Glas MacLean, on board the "Florencia" to receive an adjustment of the demands of his people. The emissary was at once disarmed and made prisoner, and no communication was allowed between himself and his friends. But Donald Glas conceived a plan, which, though it meant certain death to himself, promised a speedy and terrible retribution to his captors.

Finding that the cabin in which he was confined was close to the magazine, he found an opportunity to force his way into it, and laying a train from it to the outside he fired it, and the ship was blown to pieces, killing the three or four hundred on board.

The wreck of this vessel and the enormous treasure which she was reported to contain created a great deal of interest in the spot where she had sunk. They early excited the interest of the Argyll family, and in 1611 the Marquis of Argyll obtained as a gift from Charles I the vessel, provided he paid to the Duke of Lennox and Richmond the one hundredth part of the ship after the deduction of expenses. In 1665 the Earl of Argyll entered into a contract with one James Mauld, wherein the latter agrees to give the former one-fifth part of all that shall be recovered from the ship of the Armada lost beside Tobermory. These contracts have gone on and on, but no great store of gold and silver has been found, nothing more in coin than a few pieces now and then, though some fine brass cannon have been found.

Among the articles recovered, apart from old timber, warped ironwork, stone and iron cannon balls, human bones and skulls and silver coins, there is also a bronze breech-loading gun 4½ feet in length, one of the fifty-six carried by the "Florencia."

The gun is still in such a condition that although it lay in twelve fathoms of water for more than three centuries the monogram of the maker, supposed to have been Benvenuto Cellini, and the date, 1563, are still visible. The ball with which the gun was loaded still remained in it. The breech action is lifted out of the gun by a handle similar to a laundry smoothing iron.

A projection fits into the bore, and the wedge-shaped hole at the side of the gun has apparently been used to fasten the breech block and prevent it from being forced back by the firing of the charge. When the breech-block was removed it was found not to be solid but to have been used as the powder chamber. The iron bullet was found in direct contact with the powder, and in front of it were the remains of a wad of rough fiber, apparently manila oakum. The bore of the gun is one and five-eighths inches. A round hole at the end was for use in ramming and cleaning out the gun between the shots. This gun, therefore, takes its place among the earliest known

... gum. The [illegible] of which it has been made was not affected by the water

The broken blade of a sword, a pistol, and a hook and tackle, thickly incrusted with limestone, have also been found as well as a piece of the woodwork of the ship in a fossilized condition

The tradition is that the Florencia had fifty six guns on board and thirty million pieces-of-eight The latter still repose beneath the sand and mud of the bay making their recovery very difficult even by the methods at present in operation which are shown in the illustration

The Destruction of Weeds by Chemical Means—II*

An Important Agricultural Problem

By Harold C Long, B Sc, Author of "Common Weeds of the Farm and Garden

Concluded from Supplement No 1831, page 77

In the course of his investigations Bolley observed (1) That succulent plants and those of slow growth are more easily killed than others, (2) that flower parts and parts of plants covered with bloom or waxy coatings are more or less protected (3) that plants possessed of hairy surfaces are as a rule, more easily killed than those with a smooth surface (4) that chemicals act differently upon plants of different families even though the plants be wetted equally readily—charlock and dandelions for example, are readily attacked by copper sulphate solution while creeping thistle, wild buckwheat and clover are slowly attacked, and (5) that most of the chemicals readily destroy the tissues of any plant where the surface is broken

It was found that charlock could be sprayed with absolute success that king head or greater rag weed (*Ambrosia trifida*) could be sprayed in much the same way as charlock and with considerable success at certain times success depending on the age of the weed that creeping thistle (*Cnicus arvensis*) was most effectively sprayed with sodium arsenite (one and a half to two pounds per fifty two gallons of water) and common salt (one-half barrel per fifty two gallons of water) that succulent portions of the stem and leaves were destroyed when the plants were

Fig 10—Garden Nightshade (*Solanum nigrum* L) A Pest of Arable Land and Gardens and Poisonous to an Extent Which Varies According to Conditions

a foot high and seeding was prevented that spraying of dandelions on lawns and fields with sulphate of iron was a marked success and that the perennial sow thistle (*Sonchus arvensis*) was practically unaffected by sprays (It may be remarked that this weed only too common in Britain is quite smooth and covered with bloom)

Bolley concluded that the following weeds may be eradicated or largely subdued in grain fields by the use of chemical sprays False flax (*Camelina sativa*) worm-seed mustard tumbling mustard common wild mustard (charlock) shepherd s purse pepper grass ball mustard, corn cockle chickweed dandelion creeping thistle bindweed plantain rough pigweed, king head Red River weed rag weed cocklebur The following were found not to be effectively controlled by chemical sprays as now used Hare s ear mustard penny cress, pink cockle perennial sow thistle, lamb s quarters pigeon grass wild oats chess (*Bromus secalinus*) couch grass sweet grass and wild barley

A large number of tests with the sulphates of iron and copper were carried out some years ago by Dr A. B Frank in Germany[1] Thirty five species of weeds were involved Clover was but little damaged by a 15 per cent solution of iron sulphate (seventy gallons per acre, and one hundred and sixty gallons per acre), or a 5 per cent solution of copper sulphate the clover soon recovering after losing its first leaves In addition to charlock the following plants were more or less damaged by sulphate of iron Corn cockle poppy sow thistle corn flower

Fig 11—Corn Buttercup (*Ranunculus arvensis* L) × 1 Often Very Troublesome in Corn Fields on all Soils Especially on Chalk Often Termed Watch Wheels From the Flat Spiny Fruits

field thistle dandelion groundsel and the following were more or less damaged by a 5 per cent solution of copper sulphate (seventy gallons per acre) spurrey groundsel black bindweed Though these plants appear to be rarely destroyed they are prevented from producing flowers and seed

In experiments conducted in 1903 at the Holmes Chapel College of Agriculture and Horticulture clover was untouched when the covering oat crop was sprayed with one hundred gallons of a 4 per cent copper sulphate solution In 1899 a 4 per cent solution of the sulphate (one acre) completely killed *Polygonum Persicaria* but clover was uninjured A 4 per cent solution of copper sulphate (fifty gallons per acre) was also used to destroy charlock in mangolds the latter being uninjured

Experiments at the Agricultural Experiment Station of the University of Wisconsin showed[2] that a

Fig 12—Shepherd s Needle Venus s Comb (*Scandix Pecten Veneris* L) × 1 An Annual Corn field Weed Sometimes Extremely Troublesome on Light and Chalk Soils

20 per cent solution of iron sulphate (fifty two gallons per acre) did not injure cereals clover seedlings or lucerne, but cockle-bur ragweed dandelions daisies, wild lettuce and several common farm weeds were partly eradicated Sow thistles and creeping thistle were not effectively sprayed and it was concluded that their eradication by spraying is not practical for the average farmer

In demonstrations conducted throughout Ontario the effect of copper sulphate was observed in relation to twenty-eight weeds[3] and while charlock was the only species readily destroyed it was found that the flowers of field bindweed and white cockle and the leaves of creeping thistle sow thistle blue weed (*Echium vulgare*) and bull thistle (*Cnicus lanceolatus*) were very sensitive to the spray and largely destroyed

At the Yorkshire College Leeds experiments showed[4] that clovers were practically uninjured when sprayed with a 12 per cent solution of sulphate of iron while peas beans carrots onions beet, and parsnips were but slightly damaged and this was

Fig 13—A Plot of Lawn Upon the North Dakota Agricultural College Campus Infested by Dandelions Untreated Before Blossoming Time Left Continuation of Fig 14

Fig 14—A Plot of Lawn Upon the North Dakota Agricultural College Campus Infested by Dandelions of the Same Strength of Growth as Those Shown in Fig 13 but Treated With Iron Sulphate Solution Thrown by a Traction Sprayer Two Weeks Before Blossoming Time Compare With Fig 13 These Two Photographs Show in a Striking Manner the Effects of Spraying

the case also with swedes turnips and mangolds

Spurrey (*Spergula arvensis*) has been found to be checked by spraying with a 3 per cent solution of sulphate of copper (forty gallons per acre) flowering and seeding being checked[5] In another trial[6] the results were held to show that a 3 per cent solution of copper sulphate (fifty gallons per acre) may be relied on to kill spurrey

At the Woburn Experimental Farm it has been shown by pot trials that the common poppy (*Papaver Rhoeas*) is much injured by a 2 per cent solution of copper sulphate when the solution was applied to both surfaces of the leaves these turned brown became shriveled and to a great extent the plant was killed for the seeding was almost entirely prevented the flower heads withering completely It has also

* Knowledge.

[1] Bekämpfung d. Landw Unkräuter durch Metallsalze.—Arb. aus der Biol. Abth. für Land. und Forstw., I. Bd., 1900

[2] Bulletin No 179, 1909

[3] Ann Report, Dept Agric Ontario 1904 Vol I ( )

[4] Report on the Spraying of Charlock and Runch 1899

[5] Rept on Expts. Midland Agric and Dairy Inst 1900

[6] Univ Coll. of North Wales, Bangor Bull 11 1908

been stated that the common scarlet poppy is very sensitive to a 15 to 20 per cent solution of iron sulphate. At the Woburn Station also experiment showed that the wild onion (*Allium vineale*) may be destroyed or at least largely reduced by spraying with a per cent solution of pure carbolic acid.

Dr. Hiltner found that dodder on clover may be destroyed by spraying with a 15 per cent solution of sulphate of iron so applied that it hits both the plants and the surface soil with some force. The clover was blackened at first and appeared to be ruined but sprouted strongly afterwards.

Sulphate of iron has been found to destroy charlock if applied in the powdered condition when the dew is on the leaf, three to four hundredweights per acre being necessary. This is considered by M. Hitier to be more easy of application than in the form of a solution and more practical on small areas.

Calcium cyanamide has also been found useful for destroying charlock in corn crops.

The action of gasoline on certain plants has been observed at the Woburn Experimental Fruit Farm, and it was noted that the poppy, teasel and wild strawberry were practically killed.

The efficacy of carbon bisulphide in killing large tropical weeds has lately been discussed by E. V. Wilcox in a press bulletin issued from the Hawaii Agricultural Experiment Station, and plants appear to be destroyed owing to the freezing effect.

The results of experiments at the Vermont Agricultural Experiment Station and elsewhere are summarized in Farmers' Bulletin No. 124 of the United States Department of Agriculture, and arsenic, sulphuric acid, liver of sulphur, kerosene, copper sulphate, arsenate of soda, and so on, are dealt with.

The foregoing notes show conclusively that in one way or another many weeds may be attacked by means of solutions of chemical preparations, with good prospects of preventing seeding or of destroying the plants altogether. It is, however, still desirable that exhaustive experiments should be conducted on a co-operative basis in different parts of Great Britain for the effects of the various solutions vary with the plant sprayed, the local meteorological conditions and the thoroughness with which the work is carried out. With the results of such experiments placed clearly before them farmers would have some definite information on which to proceed.

Correspondence

Screw Propeller Design

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

Starting with the indisputable fact that any length, width and shape of a propeller blade provided it be given a positive angle will develop more or less thrust, one is forced to the conclusion that the theoretical true-screw principle of construction is not a necessary factor in producing propulsion. Further, it being a matter of record that a propeller with straight pitch, that is, with blade angles not varying from hub to tip, thus defying most theories of propeller construction, developed more effective thrust than a scientifically designed and perfectly constructed screw pitch propeller in actual competition (Lougheed, Vehicles of the Air, p. 241), I am convinced that progress requires the rejection of the screw propeller theory, which after centuries of application (dating from Leonardo da Vinci, 1452-1519) still remains even in the minds of experts (?) a mystery. So that to-day the manufacture of screw propellers continues to be a mere experiment or tentative effort toward maximum efficiency, an effort which is just as likely to be equaled offhand by any schoolboy with the medium of two shingles tacked to the ends of a broomstick.

I advance the idea and claim that every screw propeller—so called—works or advances by the effect of its rotation through the air, not as a result of its pitch angle or angles causing helical travel, but as a result of reaction of the air pressure against the compression side of the blades causing straight ahead travel, and that its rate of advance in feet per second is nothing more nor less than the terminal velocity of a surface equal to the entire area of the propeller's circle of revolution impelled by said reaction pressure against the air pressure resulting from and retarding the progressional velocity of said surface. In other words a propeller is a parachute falling horizontally. The reaction or thrust in the one case taking the place of the aeronaut's weight in the last. (This is an extreme example cited merely to illustrate the idea. In the following paragraphs I will show that efficiency in a propeller will result in great part from the proper relation of its blade widths to rotational velocity, whereby the face it presents will be the least possible percentage of the total area of its circle of revolution.)

This view is supported by the following experiment: Fix a thin blade, say one inch wide and one foot long, with its plane exactly midway and at right angles to the end of a rod. On thrusting this through a body of water or immersing it in a stream running in the direction of the axis of the rod, the resistance will be simply that caused by the water against the mere superficies of the blade. Next put the rod and blade in rapid rotation. The retarding effect against direct motion will now be increased near tenfold and is equal to that due to the entire area of the circle of revolution. By trying the effect of blades of various widths it will be found that for the purpose of effecting maximum resistance the more rapidly the rod revolves the narrower may be the blades. There is a specific ratio between the width of the blade and its velocity. This experiment, though referring to the action of surfaces in water, is yet exactly analogous to the conditions obtaining in air. (Wenham, Aeronautical Annual, 185, p. 90.)

Further support of this idea is afforded by the fact commonly experienced that a propeller which in a ground test gives from 100 to 300 pounds thrust when applied to an aeroplane and given an air test will render as little as 25 per cent and from this figure up to perhaps 30 per cent its ground efficiency. The aviator wonders why and customary thought answers "slip." Again: An advantage of the propeller in affording the starting impulse—of an aeroplane—is that its thrust is highest when the vehicle speed is lowest. Now really why? According to my reasoning because the thrust as measured in the ground test is the actual thrust (or reaction) value acting against the posterior face of the propeller disk, and when the air test is made (and the thrust apparently drops through the effect of slip) what really happens is that the thrust maintains its intensity but the propeller's actual progressional velocity is less than what screw theory demands because at said velocity the air pressure acting against the anterior face of the propeller disk equals and balances said thrust. Again quoting the parachute simile the propeller has reached its terminal velocity.

Now this reasoning explains why a straight pitch fan blower is of little value as a propeller, because its blade tips are so wide usually as to lose efficiency as regards reaction pressures through the phenomena of interference. And this width of blade multiplied by the number of revolutions per second results in the formation of a solid disk opposed to progression.

Conversely the narrow tips and blade widths of Curtiss's straight pitch propeller which defied most theories of propeller construction but proved more efficient than a scientifically designed Chauviere propeller gained that efficiency because its long narrow blades were of the best shape to obtain reaction pressures from the air and their width multiplied by the number of revolutions per second resulted in a total area less—by perhaps 50 per cent—than the total area of their circle of revolution, thus reaching their terminal velocity at a comparatively high speed in terms of miles per hour.

This reasoning also explains the cause of the greater comparative efficiency of propellers of great diameter turning slowly. The peripheral speed of the blade tips obtains great reaction pressures and the low number of revolutions per second do not nearly close the area of the propeller disk, thus letting the air from in front pass between the blades.

A very recent patent has been granted an English inventor for a propeller having perforated blades, for which great efficiency is claimed.

Need I cite more instances? No. Apply my reasoning to any type of existing propeller, true-screw, straight pitch or mongrel. What has been mystery in regard to their action becomes plain by means of the simplest arithmetical calculations. Conversely, following this idea a propeller can be designed for any duty required with much greater certainty of success than by the hit-or-miss system now in vogue.

Los Angeles, Cal. JOSEPH A. BLONDIN

Effects of Forests on Climate

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

I was very much interested in an article appearing in the SCIENTIFIC AMERICAN for October 29th, 1910, subject "Forests in Relation to Climate and Floods." The most of us readers will agree with Mr. Moore when he states that deforestation has no perceptible effect on precipitation. His figures and arguments are as to that fact conclusive. However, we take exception to his deductions with regard to the run-off of water from denuded tracts.

We choose to regard only those facts which have to do with conditions in this country. Our reason is that deductions, not figures, were given for statements with regard to floods in Europe. As far as these facts are concerned we could glean the great fact that floods are not on the increase in Europe, the continent which has perfected the system of forest conservation.

Turning to the facts with regard to our own country two stand out prominently: 1. Ground cultivated to a depth of eight inches is a better conserver of rain fall than the primeval forest humus. 2. In the Cumberland, Tennessee and Ohio rivers the number of flood days has decreased from 2,100 in 1871-1889 to 1,400 in 1890-1908. Either Mr. Moore's general deductions are based on other figures or the deductions based on the above figures are obscure to us.

1. No figures are given as to the percentage of denuded forest land that is put under cultivation. To an observer of the tracts cut off by our western lumber companies it would seem that very little is ever touched by the plow. Usually timber is on the slopes of hills that cannot be and seldom are cultivated. Where cultivation does occur I have yet to see the ground that is ever tilled to a depth of eight inches. This county, in the midst of reserves, is as large as New Jersey, but seldom do the ranchers plow deeper than six inches, the majority are satisfied with scratching the surface. So it is all over our western mountains. We would all admit Mr. Moore's first point if he could show that the greater part of denuded land is cultivated, and this to a depth of even six inches.

2. As to the second point. The mean annual stage of the Ohio varies as the rainfall—that is evident. The relative number of flood days is striking: 2,100 in the earlier period, 1,400 in the later period of equal length. Now it appears at once that in late years, 1,400 flood days have sufficed to carry off an amount of water formerly carried off during 2,100 flood days, the mean stages of the two periods indicating that approximately the same amount of water was carried in each period. It would seem that the floods were more intensified in later years while they lasted, but that they were not of such long duration. Ohio newspapers seem to bear out this fact annually when the freshets occur. Evidently the run-off in the upper reaches of the Ohio has been occurring more rapidly in late years.

We believe that this question is vital enough to ask for a more extended report from Mr. Moore. A diagram showing high and low stages with their durations would get at the crux of the matter. Again are the people of the headwaters of the Ohio ceasing to cultivate their farms? We do not reflect on Mr. Moore's deductions; we believe that he has figures that will more definitely substantiate his conclusions. May we have them? We are open to conviction.

Yampa, Colo. FRITZ TARUSCH

White Cement

COLORED surfaces or objects in cement are made by adding pigment to the surface layer, but the natural color of the cement must be taken into account in selecting and apportioning the coloring matter. For this reason numerous attempts have been made to produce a white cement. Often colored cements are made by adding suitable metallic oxides before the furnace process. Ordinary Portland cement takes its hue from the color of the substances entering into the raw material, such as iron and manganese compounds. Nearly all the clays and marls contain such oxides, so that it is difficult to have a white cement. Dr. Wormser overcomes the difficulty by a process in which he obtained white cement from ordinary clays and even ferruginous clays. The crude mass is mixed with 2 to 5 per cent of sal ammoniac and during the furnacing process this is volatilized and escapes in the shape of fumes. It may be recovered by passing the fumes through scrubbers in which the sal ammoniac (ammonium chloride) is absorbed by the water. Chloride of iron also passes in the fumes. The furnaces should be of the small vertical type and this increases the cost of production, but on the other hand the product brings a higher price. If an absolutely white cement is not needed a more economical process is to use chloride of zinc for treating. The resulting product always retains a small amount of this salt and it has a slight greenish tint.

Coloring Soft Solderings.—To impart to a copper soldering, the copper color, first prepare a saturated solution of pure blue vitriol, this is applied to the soldered place. On passing over the soldering with an iron or steel wire, it will be coated with a covering of copper, which can be thickened as desired by repeated application of the blue vitriol solution and touching with the wire. To impart a yellow color to the soldered spot, prepare a mixture of 1 part of saturated white (zinc) vitriol solution and 2 parts of blue vitriol solution; apply this to the soldered spot and rub with a zinc rod. If we desire to gild the spot, the place coppered is coated with gum or fish sound solution and dusted with bronze powder. As soon as the gum is dry, we can, as in other cases, obtain a bright surface, by burnishing.

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Snow Blindness

IN May, 1883 the explorer Jochelson, traveling alone by sledge in Northern Siberia was overtaken by a snow storm that proved to be literally blind ing." He slept during part of his enforced halt of twenty-four hours and on awakening he found him self totally blind, in an uninhabited region which he was traversing for the first time There was only one hope. He knew that the sledge was headed south ward. He drove his team of nine dogs in the opposite direction as nearly as he could judge and after a long journey in subjective darkness though the sun was shining on the fresh snow he reached the place where he had parted company with his Tunguss guides a few days previously The dogs recognized the spot and stopped But the place was deserted so it was necessary to go on—how far the blind man knew not Again the dogs stopped and pawed the ground and a sound of distant yelping indicated the presence of foxes in a burrow directly beneath the sledge While the blind explorer was trying to straighten the reins which the excited dogs had tangled the team es caped and ran away with the sledge carrying the pro visions and water Jochelson blind and destitute wandered about in the snow for several days until he reached a pile of stones which he conjectured had been employed to anchor a native tent

Under the stones he found a pool of water with which he slaked his thirst but he was so weak that he lay down to die He was rescued five days later

Hygieia the organ of the Dresden Hygienic Exhibition which recalls this interesting story adds that the natives of the Arctic regions have learned how to protect themselves from snow blindness by means which will be exhibited at Dresden next summer The natives of Alaska use richly ornamented wooden eye-shades Some other Eskimo tribes used to wear woolen spectacles pr vi d iti narrow slits but nowadays the aje t res are usually larger and are covered with bits of colored glass obtained from European visitors Ar tic expl rers and Alpine tourists usually protect their eyes with dark glasses

Rats and Plague

By G F Petrie

Altho[illegible] the r nt epidemics of bubonic plague in Chi[illegible] I [illegible] a d ther parts of the world have been always ass iat l with outbreaks of the same disease am ng rats the historical study of p ag e thr ugh o it the world reveals the singular fact that previous to 1800 ve y few references to a r it cident mortality among rats have been put on record Many ex cellent a c unts f tl ld r outb eaks notably of the Bla k Dea l in E u ope in 1347 and the Great Plague of L ndo 1 1665 are in existence but careful re sear h into these d xun ents by mo lern historiog raphers—Haeser Hirsch Abel and Sticker—has shown that for reasons difficult to dis over very scanty mention of associated rat mortality has been made

The earliest recorded instance is perhaps that given in the Bible in the acc unt of the pestilence among the Phi istines which they ascribed apparently to the mi e that marred the land Avicenna refers to the association between rats and plague in his de scription of the epidemic in Mesopotamia about the year 1000 A D Nicephorus Gregoras writing of the Great Plague of 1348 which entered Europe by way of Constantinople makes a similar reference Rats are mentioned in connection with the plague in Yun nan about 1757 and later in 1871 3 In India an as sociation between rats and plague is noted in the *Bhagavata Purana* by the Emperor Jehangir in the plague epidemic of 1615 and in a report of the Pali plague in Rajputana in 1836 Lastly Orreus refers definitely to rat mortality in his account of the epi demic of 1771 in Moscow

The identity of the disease in rats with that affect ing man was established by the discovery in 1894 of *B pestis* by Yersin and Kitasato

Within the next few years the relationship b tween rat and human plague was investigated i many parts of the world—by Thompson and Tidswell in Sydney Clark and Hunter in Hongkong Snow Weir Hankin and James in India and by Kitasato in Japan In 1905 the Plague Research Commission was appointed to investigate plague in India and the reports of this commission represent the results of the most exhaus tive inquiry into the subject that has yet been carried out

The commission early turned its attention to the relationship of rat plague and human plague and instituted an extensive examination of the rats in Bombay and elsewhere for the presence of plague in fection The maps and charts representing graphic ally the results of this examination clearly show the correlation between the epizootic and the epidemic—the rat epizootic preceding the epidemic by an interval of ten to fourteen days Every outbreak of bubonic plague when adequately investigated was found to be associated with the disease among rats The conclusion must be drawn that every epidemic of bubonic plag ie is caused by the concomitant rat plague

In Bombay the rat population is an enormous one *Mus decumanus* (the brown or gray rat) swarming in the sewers gullies and outhouses in the city and *Mus rattus* (the black rat) living in countless numbers in the houses of the people The latter species is of especial importance in plague epidemics because it is essentially a house rat it may almost be said to be a domesticated animal The severity of the epizootics in the two species will be appreciated when it is stated that during one year the examination of 70 789 *M decumanus* taken from all parts of Bombay city proved that 13 277 were plague infected = 18 8 per cent, and that out of 46,302 *M rattus* [illegible] were plague-infected = 9 4 per cent The higher in cidence of plague in *M decumanus* is explicable by the circumstance that the flea infestation of this species is more than twice that of *M. rattus*

Some interesting observations on the distribution of different species of rats in India have been made re cently by Capt R. E Lloyd I M.S The most com mon rats in India are *M rattus M decumanus* and *Gunomys* (*Nesokia bengalensis*) *M decumanus* is common both in Bombay and Calcutta, but is absent from the city of Madras It is significant that Madras is the one port in India which has never been seriously infected with plague *M rattus* appears to be uni versally distributed in India, whereas *M decumanus* does not seem to occur in India except in seaports *Nesokia bengalensis* is found in every part of India

The question of the transportaion of plague by ship rats is an extremely important one but has not so far been thoroughly worked out It would appear that *M decumanus* is the species most commonly infesting ships although *M rattus* is also found

Sticker in his history of plague epidemics quotes the statement that *M decumanus* got into Europe from Persia about the year 1725 In England *M rattus* was displaced by the invasion of *M decumanus* about this time At the present day the predominating species in this country is undoubtedly *M decumanus; M rattus* is however becoming increasingly common in the seaports

An important question in plague epidemiology is the mode of conveyance of the infective organism from the plague rat to man It is impossible even to sum marize here the numerous experiments and observa tions on this subject but it may be said that from many sides and especially from experiments in the laboratory and in actual plague infected houses, a mass of evidence has been raised which incriminates and indeed convicts the rat flea as the transmitting agent of the infection

In India the rat flea *Loemopsylla cheopis* which closely resembles the human flea *Pulex irritans* in appearance is by far the most commonly found species In England the common rat flea is *Ceratophyllus fasciatus* a single specimen only of *L cheopis* has been found up to the present time

L cheopis especially if hungry will bite man *C fasciatus* does not take to man with any readiness but will undoubtedly bite on occasion This differen e in the appetite of the two species for human blood may be of significance in determining the likelihood of the spread of rat plague to human beings —*Nature*

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Soft Solder for Metal, Glass Porcelain etc —Pour over granulated zinc a solution of blue vitriol Of the solution 20 to 36 parts are mixed with sulphuric acid of 1 85 specific gravity and while stirring 70 parts of quicksilver added washing out well and cool ing When using heat the solder to about 707 deg F (75 deg C)

Weather Foretelling (Barometer) Flowers. —One hundred parts of chloride of cobalt 10 parts common salt 50 parts of gelatine 20 parts glycerine 200 parts distilled water The chloride of cobalt is dissolved in the necessary quantity of water the glycerine added then in this is dissolved warm the salt and the gelatine previously softened in cold water When cooled filter it and in it soak the flowers etc formed from uncolored material

Cements for Water Pipes —*a* Cement lute for cast iron water pipes 24 parts Roman cement 8 parts white lead 2 parts litharge 1 part rosin All to be p lverized and mixed and then worked up into a putty with old linseed oil to which half its weight, in rosin has been added and which has then been kept at boiling heat until all the rosin is dissolved *b* Equal parts of calcined lime Roman cement pot ter's clay and loam separately well dried finely ground mixed and kneaded up with linseed oil c. Rosin and tallow melted together and finely sifted plaster stirred in until the desired consistency is obtained

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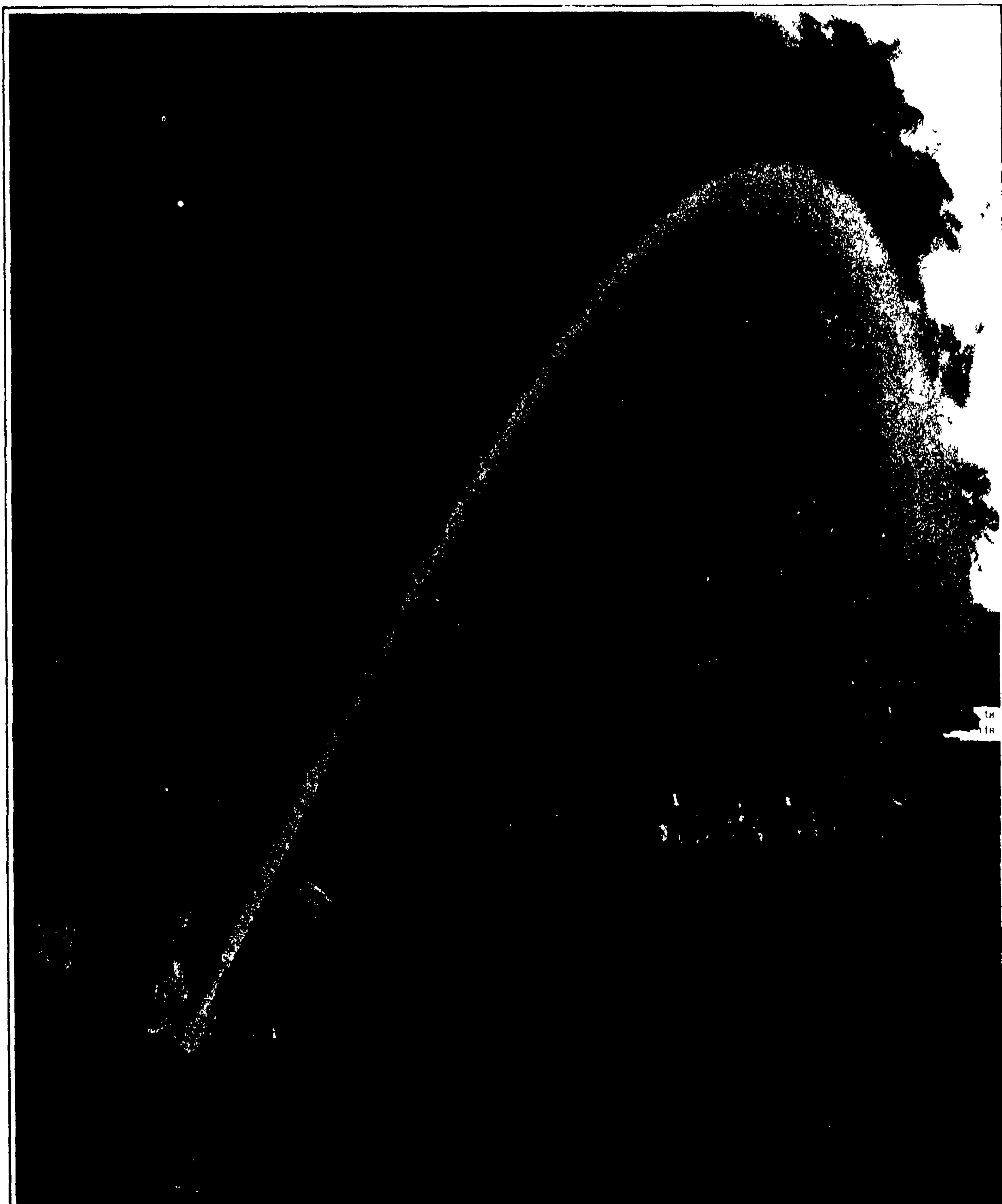


IMPROVED FIRE HOSE NOZZLE THROWING 1¼ INCH STREAM

MODERN DELUGE SETS FOR FIRE EXTINGUISHING SERVICE.—[SEE PAGE 104.]

Gas Power Development: A Review

The Possibilities of an Important Prime Mover

By J R Bibbins, M Am Soc M E

AT the opening of the present century many were the prophecies of epochal development in all branches of the technical arts I believe the decade has fulfilled its promise First by way of comparison we find the steam turbine grown from 500 to 30 000 horse power with practice both in Europe and America gravitating toward a combination of the two principal types We find single boiler units increased from 300 to 3 000 horse power we find the steam engine then fully developed now endowed with a new lease of life through association with its erstwhile rival we find the electric generator literally decimated in bulk but still larger than its turbine

But returning to the field of gas power here too is measurable progress In size engines have developed from the single acting units of 100 horse-power or so to the double-acting tandem units of 4 000 or 5 000 horse power designed for and operating under the same conditions as steam equipment including the parallel operation of alternating-current generators We find the steel casting industry then comparatively undeveloped now able to turn out intricate one piece gas engine cylinders with jackets attached and crank disks with integral pins of the same material We find producer units developed from a diminutive 10 50 horse power up to 1 000 horse-power or more and the problem of bituminous fuels well along toward solution with practice tending in the direction of the induction type for both large and small units with self contained vaporizer and continuous service Opinion is somewhat divided as yet on the tar question but all efforts are directed toward the abolition of this undesirable by product by gasifying it

Industrial Applications —But in its varied applications the direct combustion principle has indeed achieved success It is obviously no exaggeration to say that the gas engine has made possible the submarine the aeroplane the motor boat and the automobile The aeroplane motor offers an object lesson in the results of high rotative speeds The 30 horse power motor of the Wright aeroplane weighs but 6 2/3 pounds per horse-power while the Darracq motor of about the same size built for the Demoiselle monoplane weighs 3¼ pounds per horse power The Gnome engine with radial rotating cylinders weighs still less

Concerning the much discussed problem of conservation I need only refer you to the utilization of blast furnace gas by product coke-oven gas by product oil gas from refineries and various low grade or by product fuels unused for steaming purposes A large power plant is now being built for using waste cupola gas which in heat value runs about 50 B T U and requires 300 pound compression The importance of these developments in solving the smoke problem and the power problem of our specialized manufactories and in deferring the national crisis—the extinction of fuel supply—cannot be overestimated

On the one hand by reason of its high efficiency the gas driven pump has found adoption in water works sewage disposal hydraulic excavation and long distance gas transmission On the other hand by reason of the absence of stand by losses it is equally desirable in emergency service such as fire protection auxiliaries with hydro-electric plants and for canal lock operation The coincident and related development of producers has brought about a revolution in such operations as hardening tempering melting soldering baking and cloth singeing and especially displacing the supposedly indispensable Bessemer converter with the open hearth furnace in single units of 100 tons or over

Gas Engine The development of the heavy duty double acting gas engine has been accompanied by certain interesting features which while not universal yet find quite wide acceptance in American designs Foreign center crank designs have been generally departed from in the use of the side-crank self adjustable bearing construction Experience has been gained with various cylinder materials all steel or all iron steel walls only cast iron liners both iron and steel pistons and with steel on steel The trouble predicted with the last does not seem to have materialized Krupp builds thin walls with longitudinal reinforcing tension rods while other foreign builders design cast iron walls as thick as three inches Dry metallic packing has been substituted for the elaborately water cooled style Fads in valve gear have disappeared, and the mechanism has been simplified by driving both inlet and exhaust valves from a single cam

Cyclic Governing Drop Principle —In early practice the regulator was quite generally driven from any convenient point along the cam shaft but now directly from or at a point close to the main shaft so as to avoid cyclic torsional effects in the cam shaft. Direct governing has largely been replaced by the relay type using drop cut-off or positive oil pressure to actually move the valves This has permitted the use of a very small regulator usually on the German straight line principle as represented by the Jahns & Hartung design, the weights moving directly against spring pressure Mixing is now done only at the inlet valves thus minimizing the result of a back fire By the symmetrical distribution of gas and air with reference to the four inlets non uniform mixing due to unequal fluid inertia effects has largely been overcome The electro-magnetic igniter has found much favor by reason of its simplicity and has made possible ignition at several points in the combustion chamber which has brought more rapid as well as surer combustion with lean gases A series system of circulation has reduced the water consumption and also the troubles from sweating of cold rods with high sulphur gas The foreign practice of cambering rods is entirely disregarded here for with light, one piece pistons the rod flexure is not greater than considered desirable to keep the sectional packing free And finally centralized continuous return lubricating systems are the rule for engine oil with timed force feed for cylinder oil This latter replaces all attempts at graphite lubrication or indiscriminate injection of oil during combustion

The special adaptation to direct connection to reciprocating compressors has brought about the variable speed long stroke gas engine (of two diameters or more) These are operated in the natural gas districts of the Central and Western States One company alone has twenty four of these units in service of about 1 300 horse-power each An interesting feature brought out by some recent tests by the author is that for the same power output the gas and heat consumption is not widely different at full or reduced speeds

A moderate size double acting engine has also come into use with about two foot stroke whose high rotative speed (200 revolutions per minute) is of great advantage in direct connected electric drive

The gas-electric motor car is another interesting development which has been under investigation for several years by railroads for service on extensions or suburban branches where regular steam equipment would not be justified These cars are self propelled by a compact eight-cylinder high speed generating set located in the cab and standard electric motor control Sixty seat coaches ordinarily make an average schedule speed of 25 miles per hour including stops Demonstration runs have resulted in a gasoline consumption of 36 to 48 gallon per car mile A single truck car of this type has been on trial for cross town service on some of the lines in New York city that have not yet been electrified

So much for progress and accomplishment The evidence exists throughout the land from the barking thousands of small engines upon the hillsides of the Pennsylvania oil fields to the great installations at Gary Buffalo and Pittsburg—in the Mexican highlands a central station burning mesquite in Texas using lignite in Canada peat—in the Nevada Ranges a mining plant with Diesel oil engines—in Nova Scotia and Buenos Aires other engines running rail road shops—in Ohio boosting gas to Cleveland—in Arizona watering the Imperial Valley reclamation—in Philadelphia and Coney Island providing high pressure fire protection—in Pittsburg operating the locks of the Ohio Canalization project This is admittedly a good record but we should never be guilty of that smug satisfaction that blinds us to minor shortcomings so let us glance at some aspects and causes of retarded development

RETARDATION

A very serious handicap in industrial work is the present inability of the gas-power system to supply means for factory heating in lieu of exhaust steam This is particularly serious in the northern states and in Canada. Unfortunately the high efficiency of the gas engine is lost when a steam eater' is desired in connection with a heating plant. Some progress is being made with the manufacture of exhaust heaters but the available 5 000 to 6 000 B T. U. per B horse-power is not sufficient for heating a large factory Some system of auxiliary gas-burning heater must be worked out with automatic temperature control to compensate for variations in load An attempt should be made at conserving this 60 odd per cent waste heat, now rejected in the exhaust so as to return the major part of it to the heat cycle

The gas engine is roundly scored for not having over load capacity for fluctuating peak loads Now with an efficient regenerating heater operating in connection with a low pressure steam turbine auxiliary it is possible to largely increase the output, or vice versa decrease the fuel consumption I am glad to report that one of our manufacturers is working along this line on a projected plant.

We must have more convenient and practical methods of measuring power gas both with respect to volume and heating value No sensible individual would attempt to operate a steam plant without a pressure gage even neglecting the personal risk, but with gas we are working continuously in the dark and with engines equally as sensitive as steam engines to reduced potential Some large plants have of course adopted the Venturi meter but even this simple apparatus is sensitive to deposits in the throat A continuous recording calorimeter is a great necessity and some progress is being made in that directions

There is a disposition to discount the demand for large units both engines and producers With turbine units increasing by leaps and bounds the gas-power industry must respond in kind if not in equal measure or remain an auxiliary for special conditions The 44 × 60 inch cylinder is now in evidence Let us have higher rotative and piston speeds with relatively shorter stroke and larger diameters if possible It is to be expected that the production of special high strength steels and further perfection of foundry practice will make this possible This improvement in engine construction will remove one of the causes of complaint in the past on large engines—the failure of cylinders and pistons—due for the most part to shrinkage strains

Nor can it be believed that the producer fuel bed has reached the limit of its diameter nor the maximum rate of gasification With a coal combustion of fifteen pounds per square foot per hour an eight-foot producer would yield only 700 B horse-power Marine and locomotive practice with induced draft succeeds with many times this rate A full grown power plant of to day requires units of 3 000 to 5 000 kilo-watt capacity with at least 2 000 horse power producers

Finally education not only of operator but of salesman and manufacturer is needed The last named is often the least wide awake, and the first the most receptive of intelligent guidance The great mistake is made in semi-education—first an incomplete understanding of the conditions second a make fit equipment third a jealous guarding of essential knowledge of defects The result is loss of confidence dissatisfaction failure When will we learn that to take the operator into our full confidence secures his allegiance for all time

THE FUTURE

Marine Propulsion —This most important development looms big on the horizon Much has been written of the producer gas system but it must be confessed that the oil burning engine is more attractive from the standpoint of convenience and compactness The advantage of storing oil in the ship's double bottoms is great from a standpoint of cargo capacity European countries have been active in this development, Russia with its tank ships, France with its submarines, and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland water ways of Europe where coal is the cheaper fuel, and a boat is now being equipped here for service in New York Harbor

Recently has come the announcement of the adoption of oil engines for the 8,000-ton 12 5-knot freight boats now being built by the Hamburg-American Line These will be equipped with two 1,500 horse-power Diesel [illegible] built by the Augsburg & Nurnberg Works and if the experiment is successful similarly propelled passenger vessels will [illegible] structed One American builder, [illegible] up the Diesel engine for marine work.

Power From Crude Oil —The oil engine development seems to have made great headway abroad since the expiration of the basic Diesel patents. Two of

Chairman's address before the Gas Power Section, American Society of Mechanical Engineers New York December 1910

the principal companies have built together 250 000 horse-power with four and six-cylinder units up to 1,000 horse-power capacity per cylinder Small Diesel engines have been built from five to thirty horse-power The smaller engines are mostly four cycle, while above 1 000 horse power the two-stroke cycle prevails, which in an oil engine works out much more simply than in a gas engine where sep arate pumps are required for gas and air Maxi mum compression is somewhat over 500 pounds with air injection at 600 to 850 pounds In most cases the compressors are built into the main unit and geared Some of the builders are reported to be developing double-acting designs for engines of high power

In London one of the electric supply companies has installed Diesel engines using oil distillate to supplement the transforming equipment of its sub stations, at a cost per kilowat hour lower than that for the main stations A somewhat similar type of plant-operating in one of our eastern cities boosts the potential of low points in a direct current distri bution system The generators however are under compounded so as to limit the output and thus equal ize with other parts of the network Obviously the oil engine is an ideal prime mover for such service

In the various experiments with oil gas producers the small progress has been discouraging Two sys tem have been used the retort and the partial com bustion In the former difficulties with carbon depo sition in the retorts are encountered in the latter excessive production of lamp black Both are hope lessly low in efficiency as compared with the oil burning steam plants A large oil gas plant in Cali fornia operating gas engines as water power auxili aries endeavors to apply to power purposes mixed gas consisting of part retort and part carburetted water gas utilizing the carbon deposits of the former as briquettes in the latter process In this mixed gas the hydrogen content is kept down to about 30 per cent but in the oil gas it is very much higher 40 to 60 per cent For straight power purposes the combustion producer seems more promising both in simplicity and efficiency The Imperial Valley pro ject is being served by a small lift station of this type at Yuma Arizona

Power in the West Closely related is the de velopment of the Western power fields both for ir rigation and for mining operations The Easterner cannot realize to what extent irrigation has taken hold of the West and what a field there is for power pumping if it can only be developed Utah Arizona Texas and the Great Plains embrace broad areas underlain by basins or hardpan yielding ground waters at a depth varying from a few feet in favored areas to 50 to 70 feet in others At present electric power pumping is predominant John C Hays * in discussing a California installation men tions an area of 1 050 square miles 86 per cent of which is electrically irrigated He declares there is no reason why this field should not be open to gas power pumping One installation is already pro jected with gas driven generators but why not di rect pumping? No one familiar with the ever pres ent gas pumpers of the oil fields will fail to see the parallel But we must have a low priced engin simple fool proof and preferably of high speed multi cylinder type adapted to direct connection to centrifugal pumps Present types of high speed en gines are not really adaptable to rotary pumps be cause of the disparity between impeller proportions and engine speed although a few sizes can be found suited to low head work The new Humphrey gas pump is evidently well suited to this service In fact some of these pumps are now operating in irri gation enterprises in India Recently a unit as large as 25,000 000 gallons has been contracted for This pump utilizes the water column itself as a piston and is approximately fool proof

A crude oil engine is obviously a necessity in the Far West East of the Rockies lignite suction pro ducers in small sizes would find application but in California, oil predominates In 1908 the oil produc tion in California was 48 300 000 barrels at an aver age price of $0 54 per barrel The majority of this was asphaltum base oil 12 deg to 17 deg Be

In the mining districts we find wood charcoal and black lignite used for steaming purposes even where water is scarce and impure One plant, however ac cepted the situation and installed Diesel engines with a continuous, closed, fan-cooling system for jacket water

The development of lignite deposits in the Middle West is encouraging In 1907 the output west of the Mississippi was 5,000,000 tons of which Colorado produced one third, with Wyoming and Texas next in rank, with an average price of $1 55 per ton as com pared with $1 12 for all bituminous coal mined in this country This price does not, of course, apply to the more inaccessible regions, where fuel costs $4 to $8 per ton Here in the West is an opportunity

Canada—We have looked to Canada for important developments in the use of peat, but private experi ments have failed so signally that the government has started a peat manufacturing and power plant to demonstrate the process on a commercial scale and re establish confidence in this industry Director Haanel of the Canadian Bureau of Mines thus summarizes his investigations Artificial drying processes have failed commercially and a machine process must be substituted for the manual labor The department is therefore proceeding along European lines of es tablished success He states that Russia alone pro duced 4 000 000 tons of peat fuel in one year 1900 Peat containing not over 25 to 30 per cent water has been found an ideal fuel for gas producer work It requires no further vapor and is quite free from high temperature and clinker The long series of fuel tests at Montreal have served to confirm the results of our own government's tests on lignites in demon strating the great possibilities of these lignite deposits especially in the Canadian Northwest

Self Starting Engine No real progress is ap parent in the self starting gas engine Some automo biles are equipped with small compressed air motors but at considerable expense No simple combustion method has yet appeared The opportunity is clear On very large units one builder employs for start ing an explosive mixture compressed to about 80 pounds and stored in the same manner as the usual compressed air Some trouble has been experienced in guarding against back fires into the storage tank

Double Deck Stations—In large cities where land is dear a new style of power plant would seem to have some possibilities viz the double deck type with the produced plant above This has some ad vantages over the familiar double-deck turbine plant in that the steel work of the building would be de signed for a dead load concentrated along the sup porting walls where the producers would naturally be located I am not sure of the comparative costs but the economy in spa In a large plant works out relatively low

Engineering Economics Returning now to a consideration of some of the broader aspects of this subject it seems to me that there are some fruitful fields still undeveloped Engineering to-day has be come not entirely a technical but an economic sci ence as well We must not only ask the question Will it work? but first and foremost Will it pay the proper return on the investment? Consider for example the total cost of power production How much earnest effort has been thrown away in fruit less discussions of mere operating costs technical finesse when the language of fixed charges depreci tion obsolescence super cession and business risk had not fully been learned This phase of gas power de velopment has been of serious consequence in the past and undoubtedly responsible for many of the fail ures on record Such problems continually arise in the course of comparative studies of gas producer and turbine plants with various load factors and prices of coal The success of the by product coke oven industry in realizing profits from its by products rests solely upon the economics of the case and abruptly raises the question Which is the major product gas or coke? The analysis of the cost of production is of far more importance than that of microscopical improvement in efficiency

Technical Consular Attaché—No one can deny the great value of detailed knowledge of the develop ment of the arts in foreign countries Private in dividuals or corporations constantly invest large sums in securing such information for their purposes Now in view of the extended activity of our govern ment along scientific and commercial lines as evi denced by the Geological Survey the Bureau of Mines the Bureau of Standards and the Smithsonian Insti tution does it seem unreasonable to broaden the use fulness of our consular service by the establishment of a new function a technical investigating staff whose duties would be to keep constantly before American engineers the more important achievements of for eign contemporaries? The excellent report on Peat and Lignite by the Canadian Bureau of Mines is a case in point The fact is that progress to-day is so rapid that no individual can hope unaided to keep abreast without expending time in general investiga tion that should properly be detailed to special talent And it seems to me that the national engineering so cieties should be the leaders in fostering this activity

Co operative Research—The movement toward the co-operation of the engineering fraternities with the educational institutions should be encouraged first by the more widespread establishment of technical ap prenticeships in our shops and offices It is no ex aggeration to assert that to-day the technical grad uate furnishes the new blood of industrial enterprise His training and his ideals form the ground work of a steadily improving standard in commercial life By the same token the colleges have a right to ex pect co-operation Their costly laboratories are at our disposal for the asking We spend millions in commercial experiments that can at least only yield approximations Many of these investigations should be transferred to the laboratory

There is now before the technical institutions of the country a comprehensive list of subjects need ing scientific investigation many of them of the ut most importance Could we persuade the manufac turers of the country to endow graduate fellowships in their chosen fields with ample funds for defray ing the material costs of such investigations the re turn on their investment I believe would be well above the market rate of interest A few pro gressive concerns have taken this step but they may only be regarded as a precedent One technical in stitution has itself provided an endowment

Interest the student in your business by affording him some incentive and he will become a loyal ap prentice an effective salesman and a competent ex ecutive I beg to suggest that this section take more definite action through the society along these co operative lines As subjects I need only mention the following as typical Are there any manufac turers interested?

(a) Maximum efficient rate of combustion in pro ducers as affected by width and depth of fuel bed rate of blast moisture content and character of fuel

(b) Study of chemical reaction in the fuel bed to determine the conditions for suppressing the form tion of tar or lamp black and securing maximum percentage of combustibles in gas together with high overall efficiency

(c) Study of the relative jacket absorption with varying time contact due to different combustion chamber and cylinder proportions and piston speeds

(d) Effect of auxiliary precompression of charge on efficiency and power of gas engines with refer ence to securing unlimited overload capacity

(e) Determination of the most suitable form of gas engine indicators to standardize accurate meth ods of working

(f) Research work on maximum heat values of combustible mixtures standardizing formulæ for the standard reference cycle

Work of the Section—Finally as to the work of the Gas Power Section The interest manifested in the last few meetings indicates that it has been pro ductive of results Out of 180 papers presented to the society within the last five years twenty four have been devoted to gas power or related subjects two committees have presented comprehensive re ports and a third committee its detail work from time to time Although none of the committees now at work have reported conclusively their preliminary reports have furnished ample basis for further action Possibly the most pressing need is the standardization of tests and efficiency determinations These matters were brought to the attention of the society in con crete form by the standardization committee of this section and are now in the hands of the power test committee of the society

The greatest value therefore of the section rests in the contribution to the art in the papers or reports presented We should not glory in mere numbers but on the other hand excessive concentration in the choice of subjects does not effectively reach the full membership We may well accept the two contribu tions on blast furnace practice as an earnest of our desire for contributions of the highest possible stand ard I have heard Lord Bacon quoted on this theme I hold every man a debtor to his profession from the which as men of course do seek countenance and profit so ought they of duty endeavor to be a help and ornament thereto This seems sound doctrine and in the belief that it will not fall on arid ground I look for the continued growth of this membership with the very keenest interest

* American Institute Electrical Engineers May 1910, The Mount Whitney Power Co.

Although the home of the tin plate and sheet mills South Wales is hardly an important center for the manufacture of ordinary steel rolled sections or of pig iron it is now stated that two new steel works at Barry in South Wales are in contemplation as well as another at Irlam on the Ship Canal According to published statements the larger of the two Barry schemes will be very complete and will embrace blast furnaces and steel works for the production of sheets and heavy rolled sections The other works is ex pected to specialize in heavy rolled sections The Irlam works like the Barry schemes will depend largely upon imported raw materials anyway upon water borne materials except as regards fuel Middles brough and the Clyde districts cannot be expected to welcome these new additions to the steel industry It is to be noted that other recent additions to British iron and steel industries have shown a disposition to situate themselves in other districts more especially Lincolnshire and South Yorkshire

Correspondence.

The Improvement of the Flying Machine

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT

Recent events in the science of aerodynamical flight have followed preceding flying feats with so marked an advance that to the layman it would appear that the true subjugation of the air is accomplished beyond dispute. Yet to the impartial student of natural and artificial flight it cannot honestly be conceded that progress with mechanical flying machines has justified the belief that it is commensurate with the vast number built and experimented upon. Indeed the skill of the pilot has progressed more than the improvement and evolution of the machines. It is the object of this article to consider precisely the question of both natural and artificial locomotion in the air, and to analyze recent experiments on the one hand with their obvious faults, and on the other demonstrate those superior qualities enjoyed by Nature's machines whereby they excel man in the real conquest of atmospherical space. From the analysis it will be shown that there are neither subtle mysterious laws nor inscrutable mechanics in nature as exemplified in the volant bird, bat, or insect that cannot be faithfully reproduced by the methods and intelligence of man, and that in comparison with the feats of the bird he not only accomplishes them but actually surpasses them.

Without describing exhaustively the structure and the infinite number of designs discovered in the animal kingdom, it may be remarked that the earliest known flyer is the extinct pre-historic pterodactyle (*Pterosauria*), wing-fingered specimens having been found in their fossilized form in the cretaceous rocks of America and England with membraneous wings 25 feet span. In striking contrast is the tiny *Diptera* or two-winged, with microscopic-sized rudimentary posterior wings or halteres which act as balances in flight, seen in the house-fly, wasp and bee. To this order should be added *Coleoptera*, comprising the beetles; *Hymenoptera*, butterflies and moths; *Adonata*, the wonderful dragon-fly; *Cheiroptera*, the bats; and

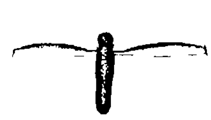


Fig. 1.—The Insect's Wing Traveling in Horizontal or Waved Figures of 8 Line of Progression Shown by Dotted Lines.

lastly the countless designs observed in the perfection of flight, the true aeroplane, the bird. Varied in structure and contour though all may be, it is significant that *all* fly on one and the same principle—or possess the power to accomplish it—that of the screw. Innumerable in variety, some being falcated or scythe like, others oblong or rectangular, others rounded or circular, while others again being lanceolate or linear, the fact remains that whereas the *designs* need not be restricted in number the main principles and agencies underlying the same must not be departed from if the conquest of the whirls and eddies of air is sought. Note therefore that there must be neither divergence nor departure from natural laws. *A thorough knowledge alone will enable us to design fundamentally and construct a true flying aeroplane.*

Hence without unduly enlarging on structural points in nature, we know as demonstrated by Pettigrew's life work that the wings of birds, bats, and certain insects are of helicoidal curvature with a certain concavo-convexity of form near the shoulder, while all are semi-rigid anteriorly and flexible posteriorly and toward the tips, also graduating in thickness from the root and tapering to a fine plastic point at the tips, which enable the pinions to be automatically stable when encountering opposing winds or those of a vertical tendency, and consequently conferring those fine qualities which react upon the air with such efficacy in obtaining the maximum of horizontal displacement or support while securing a minimum of resistance in flight. They form both structurally and functionally reversing screw propellers, one primary feather in fact being equivalent physiologically and morphologically to one whole wing.

It is however the following points that the writer wishes to enhance, as they constitute the key to the whole problem of success and are the true dogma and distinguishing feature whereby the subjugation of the air *must* be accomplished. Wings, besides being structurally and functionally powerful propellers, sustainers and elevators of remarkable efficacy when beaten in helicopteral flight in forward translation, have their sail area of apparent inefficient dimensions, and one would imagine wholly incapable traveling surfaces. Quite so. Yet Nature, foreseeing that in order that her children should subdue and not be subdued, increases the sail area by bewildering rapid motions or beats, thus augmenting the dimensions and creating *solid bases of support* by superior speed, perfected traveling surfaces designed to satisfy the resiliency of the air and the inertia of the mass of the flying animal, and superior power residing in the powerful pectoral thoracic muscles. Slight though these may be in comparison to the enormous weights and motors of man, there is no gainsaying the fact that natural machines soar in winds and accomplish feats we have hitherto failed in, thus furnishing a practical demonstration that the *whole wing-area is utilized* to con-

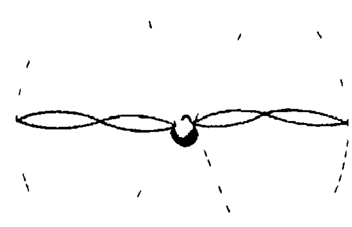


Fig. 2.—The Effective Sustaining Area Due to the Sweep of a Bird's Wings.

summate the triple function of propelling, sustaining and elevating the flying creature. Figs. 1, 2 and 3 illustrate this principle concisely, the first showing the insect's wing traveling in a horizontal path or a waved figure-of-8 line of progression as shown by the dotted lines, the second representing the bird, the last illustrating the screw propeller of man reproducing precisely similar principles and results in rotation in a circular path against the reciprocal motion of the bird and the insect. Here then is the first simple triumph and improvement mechanically furnished by Man over Nature, i. e., the transference of reciprocating into rotary motion.

Accepting the bird as the ideal aeroplane model, we find that steering at right angles and horizontal movements present little difficulty and are accomplished in a variety of ways. A bird flying diagonally through the air attains its maximum of support or pressure at the front edge of the wings; increase of velocity tending to thrust up the anterial margin, the bird counteracting this by accommodating its center of gravity farther forward, backward, or raising and lowering the same in accordance to conditions. This is secured by (1) raising the wings in a dihedral angle above the body, resulting in lowering the center of gravity; (2) flexure of wings against the body, thus bringing the same farther forward; (3) throwing conversely the wings forward and so correspondingly reversing the conditions; or by (4) extending the head and neck as in the case of the pelican, stork or flamingo, and spreading the tail. Steering is effected either by (1) raising one while depressing the other; (2) diminution of the parachute area of either wing; (3) twisting the pinions into an helicoidal curvature, which principle is that copied by the Wrights and confiscated by all other aeroplanists; (4) or by raising and lowering each side of the tail. Compare the varieties of movements and capabilities with the superior qualities of flexible construction of wings and latent power to beat them against the inert immobile and passive sail area of the aeroplane, which can readily be detected. In Fig. 4

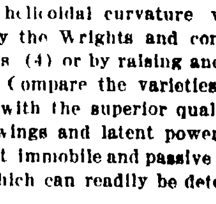


Fig. 3.—Screw Propeller, the Dotted Line Gives Projected Area.

is shown in section an ordinary Blériot type monoplane of some 30 feet span, with the usual 6 feet 6 inches tractor in the center. The insufficient active surface of the same is portrayed by the dotted lines, clearly demonstrating the poor comparison of active *versus* passive sail area, the latter predominating in excess as against Nature's examples where the *whole area is utilized*. If, however, the aeroplane surfaces are constructed with flexible tips and posterior margins, and twin screws are employed of twice the diameter of propellers, it will immediately be recognized that these superior qualities seen in the bird are greatly enhanced and ability to fly in stronger winds is attained by simple means. As an illustration of the inability of the modern aeroplane lacking adequate means of conquering adventitious currents, the writer quotes from the report of the Blackpool aviation meeting in England, from an aeronautical contemporary: "Owing to the strong winds varying in velocities, no aeroplanes ventured out from their sheds even, and the only aviators seen aloft were the sea-gulls, and *they* flew all day long."

Thus the incontestable fact remains that although certain aviators like Latham, Paulhan or Johnstone have flown by superior skill in winds which others dread, it is for a brief period only, while the slight power residing in the muscles of the gulls, compared with the 50 to 120 horse-power and great increase in the mass of machines weighing from 600 pounds to nearly a ton, sufficed to enable the bird to beat man's efforts at subjugating the air by simply adopting well defined proven laws instead of copying others' faults as man is content at present to do!

From the foregoing remarks, which are briefly subtracted and amplified from the lecture given by the writer entitled "Flying Ships of the Future" in 1908 at the Royal United Service Institution, Whitehall, England, it will be conceded without prejudice that a remarkable co-relation exists in the laws of nature and the improved flying machine built by man. Indeed, in order to prevent repetitions of fatal accidents with the modern *incomplete* aeroplane, the cause is not far to seek, as the foregoing lines demonstrate in the remedy presented. The world is asking for enlightenment in this respect, but how correct are the explanations? Certainly not by constructing the traveling surfaces of the aeroplane wings more rigid, heavy and inert. No. Flight by mechanics is the product of superior inertia, volition, power, and *properly constructed* traveling organs or wings, and there can be no question that under such conditions machines embodying these requirements will afford a veritable example of *multum in parvo*, and will make flights around the world over sea and land perfectly feasible. Given adequately powerful reliable engines, improved traveling surfaces, either rotary or reciprocal, and *whose active area predominates*, whereby is elicited a responsive upward and forward recoil on the air instead of inert passive surfaces seen in the present aeroplane,

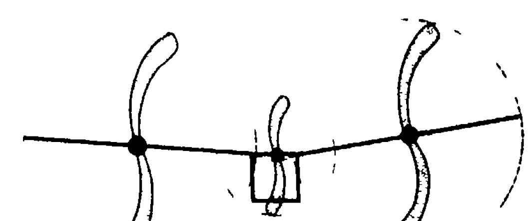


Fig. 4.—Section of Blériot Monoplane. Dotted Lines Show the Passive Compared with the Active Sail Area of Birds and Insects.

the perfected yet simple airships with these essential features will literally forge itself with the potential aid of gravitational energy and the immense inertia of the dynamic mass through all resistances of wind tending to deflect it from its path, thus ensuring the *true subjugation of the air*.

Pimlico, London. EDGAR E. WILSON.

Guns in Mine-laying Vessels

THE question of providing suitable gun arrangements for mine-laying vessels is, it is reported, engaging the serious consideration of the British Admiralty. This valuable type of auxiliary vessel has as the result of the trials and experiments carried out since its inception developed into a single independent unit. Being self-contained and therefore ready at all times to act on her own initiative, she can select the most suitable time as regards weather conditions and also take the best route to proceed as rapidly as possible in order to achieve her object, namely the blocking of a possible enemy's port. This line of development has of necessity taken her farther and farther from the original conception of her duties, which was to act as one of a group of similar vessels under the protection of an escort of cruiser or battle units. This change has rendered the question of her protection against possible attack when moving to and from the danger zone one of vital importance. In the case of the "Intrepid," recently converted for use as a mine-layer, it has been decided to provide her with an armament of 6-pounder quick-firing guns. This is, however, felt to be only a tentative measure, as these excellent little guns are now quite outclassed by the improved armament of 4-inch and 12-pounder, or their equivalent in foreign navies, which are now mounted on modern destroyers. In circles competent to judge it is considered that a small mixed armament of 4.7-inch—of which there are a large number in reserve—and 12-pounder quick-firers would be an ideal armament for this class of vessel, or at least nothing smaller than 12-pounder guns should be included.

The Gas Turbine*

A Consideration of Proposed Types

By A W H Griepe

It is generally recognized that one of the chief difficulties in the way of devising a practical gas turbine is to find a material for the vanes which will be capable of withstanding the effect of being in contact with gases at the high temperatures produced by combustion

Properties of Gasoline and Air

Test Number	Mixture Volume		Time in Second Between Ignition and Highest Pressure	Explosive Force in Pounds per Square Inch			Temperature of Combustion in Deg Fah	Temperature of Combustion in Deg Fah
	Gasoline Vapor	Air		Compression of Air in Pounds per Square Inch				
				42	5	1	Actual	Theoretical
1	1	18	(28	150	208	261	1877	3545
2	1	11	0 18	183	244	307	2198	4010
3	1	9	0 18	234	316	390	2403	4806
4	1		0 07	261	348	435	3119	6001
5	1	5	(05	270	300	450	3259	6951
6	1	4	0 07	240	320	400	2965	5 1

* At atmospheric pressure

The actual temperature of the gases however though high does not approach the theoretical temperature as is shown in the table the figures of which they obtained in laboratory tests made by Dr Richard Wegner of Heidelberg Germany

Forcing steam or water into the rotor to cool the blades has been suggested as a means of preventing their destruction by the high temperature gases This arrangement to be effective would no doubt complicate the construction of the turbine considerably and would probably reduce its efficiency

An excess of air in the mixture has also been suggested as a means to this end The effect on the explosive force of the mixture is clearly shown in the table Several attempts have been made to use blades made of heat resisting materials such as quartz and slate etc Hard porcelain reinforced by wire mesh has also been tried but with very little success

Blades made of vanadium steel and covered with a layer of magnesia have shown the best results so far but have not proved sufficiently good to warrant the use of this combination

Fig 1 represents diagrammatically a gas turbine of the velocity stage type coupled to a three stage centrifugal air compressor as proposed by Dr Stolze† of Charlottenburg and described in a paper read several years ago The gas which is controlled by the flyball governor enters the explosion chamber under pressure and is mixed there with air (under pressure from a three-stage centrifugal air compressor) The mixture is fired in the chamber after which the air and hot gases expanding in the nozzle enter the turbine where they give up their energy in much the same manner that steam does in the steam turbine passing the rotating and stationary blades on their way to the exhaust outlet

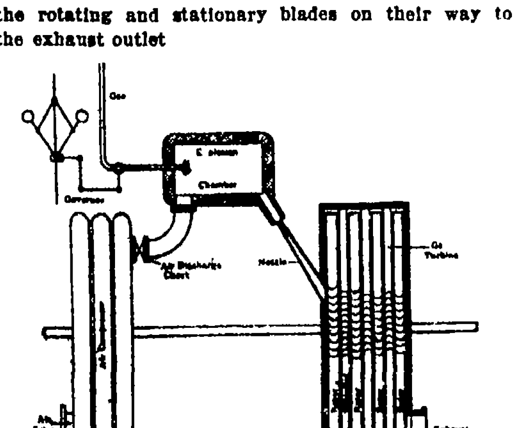


FIG 1—DIAGRAM OF STOLZE'S PROPOSED TURBINE

An improvement has been proposed for this type of turbine unit which consists in forcing steam or water into the combustion or explosion chamber in order to reduce the temperature of the burning gases to a temperature that will be safe for the vanes

Fig. 2 is a more or less diagrammatic sketch showing an elevation and cross-section through a reaction type of turbine proposed by Dr Wegner and described in a paper written two years ago

* From Power and the Engineer

† This arrangement is attributed to Rudolf Barkow by Mr Supino in his book "The Gas Turbine."

The turbine rotor is made up of four tubes closed at the outer ends and flanked on each side by round plates as indicated These plates are provided with circular openings which admit air for cooling the tubes after each explosion (See the elevation) The tubes and plates revolve on a shaft in the direction indicated by the arrow

At the outer end each tube is a De Laval nozzle and near the center of the hub are two openings axially opposite each other for use in the admission of gas and air both openings being guarded by check valves The gas check valve as will be noted is connected to a ring which passes in front of a segment with a circular opening which admits the gas

A spark plug is attached near the outer end of each tube as shown in both views

When passing by the gas admission segment each tube is filled with gas and air through the check valve ports The gas is under a higher pressure than the air and therefore forces the air check valve to its seat and as the turbine revolves further the centrifugal force compresses the mixture in the outer ends of the tubes The spark plugs then ignite the mixture after which the hot gases escaping under pressure through the De Laval nozzles force the turbine to revolve in the direction opposite to the outflow of the gases

After the explosion occurs the check valves open again admitting cool air which clears the tube of the burnt gases at the same time cooling the tubes As

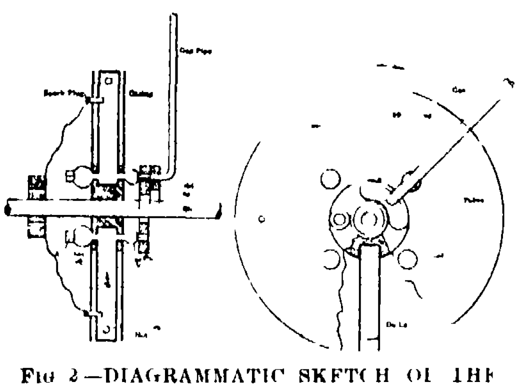


FIG 2—DIAGRAMMATIC SKETCH OF THE WEGNER PROPOSED GAS TURBINE

the casing and tubes revolve air is sucked in through the cooling air inlets (shown in the elevation) which further facilitates the cooling of the tubes after each explosion

Four explosions occur for each revolution of the turbine and the reaction of the outflowing gases against the atmosphere is the source of the power

The turbine is therefore a reaction turbine in its simplest form making separate air compression unnecessary

THE GRIEPE TURBINE

Figs 3 and 4 show a gas turbine designed by the writer which is really a combination of the gas engine and gas turbine The unit consists of the turbine a three stage centrifugal air compressor an air accumulator and a gas chamber The whole unit is set on a common base which is built out as an exhaust chamber

As will be noted from the following description the flow of hot gases against the blades is intermittent

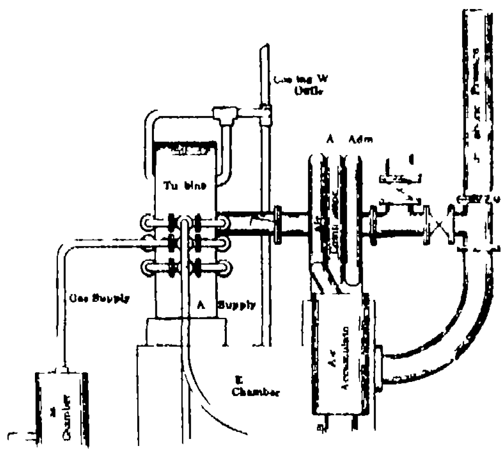


FIG 3 COMPLETE ARRANGEMENT OF GRIEPE'S PROPOSED GAS TURBINE UNIT

which gives the blades time to cool somewhat between the moments when they are in contact with the gases

The rotor A (Fig 4) which is shown in black is made up of a series of expansion chambers containing blades B and a series of closed compartments C which separate the expansion chambers The rotor A carries a ring D having openings E to admit gas from the gas chambers to the explosion or combustion chambers F

Contact pieces G fastened to the rotor close the electric circuits of the spark plugs which are located in the walls of the explosion chambers Explosion chambers are provided on both sides of the rotor web but are staggered angularly to avoid dead positions

The main structure contains compartments for compressed air cooling water and gas as shown

The explosion chambers F are located on the outer part of the central structure and are alternately closed and opened to the expansion chambers by the inner faces of the compartments C The explosion chambers may be as shown or carried completely around the circumference of the central structure according to the size and power of the turbine

Compressed air from the compressor passes through the four way valves K which act as injectors The air draws a certain quantity of gas along with it while passing through the valves and the mixture is forced

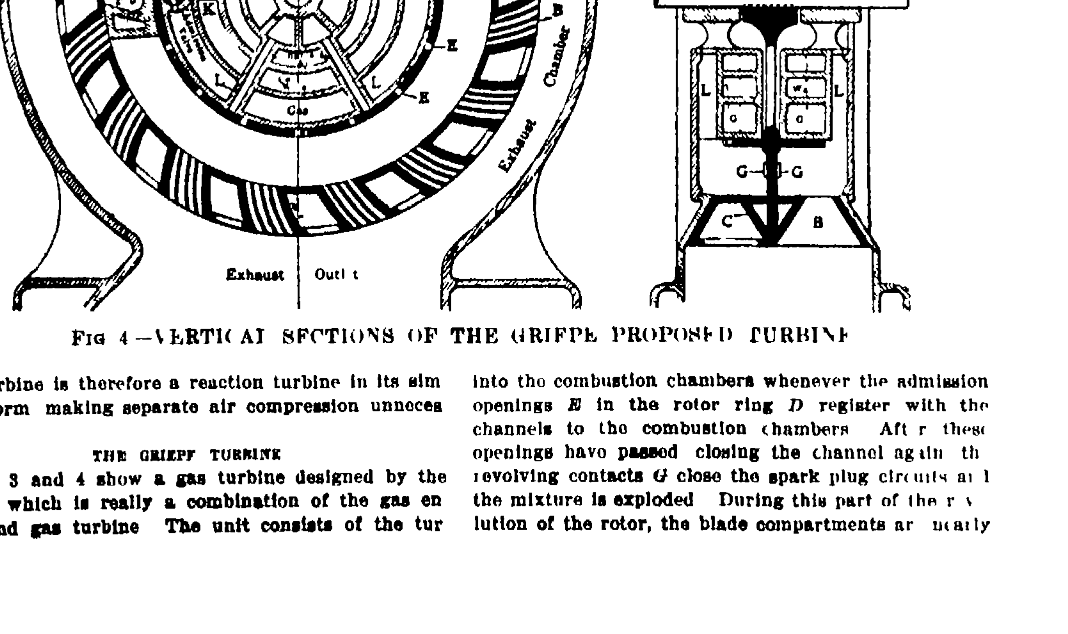


FIG 4—VERTICAL SECTIONS OF THE GRIEPE PROPOSED TURBINE

into the combustion chambers whenever the admission openings E in the rotor ring D register with the channels to the combustion chambers After these openings have passed closing the channel again the revolving contacts G close the spark plug circuits and the mixture is exploded During this part of the revolution of the rotor, the blade compartments are nearly

opposite the explosion chambers and an instant later they register and the gases escape through the vanes forcing the rotor in the direction of the arrow Further motion of the rotor brings the compartment C again over the openings of the combustion chambers and the cycle is repeated

In the design shown here it is evident that the vanes or blades *B* are not continuously in contact with the high temperature gases, as during three-quarters of a revolution of the rotor the blades are surrounded by gases at a lower temperature cooled by air admitted through the air channels *I* into exhaust chamber

The centrifugal air compressor driven by the turbine discharges into an accumulator to insure uniform air pressure The density of the explosive mixture of gas and air can be regulated by adjusting the air pressure

A further change in the output of the turbine can be attained by opening or closing one or more of the four way valves *K* thus changing the number of explosion chambers in action

Production of Low Temperature and Refrigeration—I*

The First International Congress of Refrigerative Industries

By L Marchis

The first International Congress of Refrigerative Industries held at Paris October 5th 12th 1908 was remarkable for the number and importance of the papers submitted by the men of science and engineers who responded to the call of the organization committee

The congress was divided into six sections as follows

First section Low temperatures and their general effects

Second section Refrigerating media

Third and fourth sections Application of refrigeration to food and in various other industries

Fifth section Application of refrigeration in commerce and transportation

Sixth section Legislation

In this article we do not intend to summarize the memoirs and communications presented but rather to give a general view of the congress that brought together men of science engineers biologists legislators and men from the business world

I LIQUID AIR AND THE PROPERTIES OF BODIES AT LOW TEMPERATURES

The first section considered principally the production of liquid air and the preparation with this as a starting point of oxygen and nitrogen in a commercial way

It is well known that air like all gases is brought into a liquid condition by the combined effect of lowering its temperature and expanding it sufficiently In carrying out this process gaseous air cooled to a low temperature is expanded suddenly from a pressure p to a lower pressure p Part of it goes over into a liquid state and the other part gaseous and very cold is led into an economizer where it cools down the air that is being compressed to the pressure p for the first time

The essentially adiabatic expansion of air can be effected in two different ways

(*a*) Air compressed to the pressure p may be expanded without doing available exterior work It passes from the compression tank to the liquefaction tank by the way of a narrow orifice This is the manner of expansion adopted by Linde in his liquid air machines The lowering of temperature obtained under such conditions is only appreciable if the difference between the pressures p and p is considerable In Linde's apparatus† gaseous air cooled to about 100 deg C is expanded from a pressure of 200 to 40 atmospheres the liquefied part of the gas at about 140 deg C passes into a regenerator where it cools the air compressed at 200 atmospheres It is then led into a pump which brings it up to this latter pressure A second auxiliary pump draws air from the atmosphere to take the place of that part which has been liquefied In the industrial machines the gases compressed to 200 atmospheres before passing into the economizer where the gas at —140 deg C circulates are cooled by liquid ammonia

Under such conditions in machines which produce 0 liters per hour the yield of liquid air is about half a liter per horse power hour

(*b*) The second method of air expansion consists in utilizing the exterior work which the gas is capable of doing when it passes from pressure p to p This mode of expansion with utilizable exterior work is the basis of the processes of G Claude for the production of liquid air‡ Air compressed to a maximum pressure of 0 or 40 atmospheres passes first to an economizer where it is cooled down as in Linde's apparatus by un liquefied gas It is then expanded in the cylinder of a motor whose energy can be utilized in the original compression of the air In course of time a partial liquefaction of the air occurs in the cylinder of the auxiliary motor The lubrication of this cylinder is accomplished by means of a petroleum distillate having a specific gravity of 0 675 (automobile gasoline) which at the low temperature at which the motor operates attains a sirupy consistency comparable to industrial lubricants

Applied in this form the process of G Claude gives only unsatisfactory results The expansion of the air occurring at temperatures of —175 deg to —180 deg by the gas expanding in the auxiliary motor takes place under unfavorable conditions The appearance of liquid air in this auxiliary cylinder is likely to produce a peculiar water hammer effect and is accompanied by a large increase in friction that is to say by a correlative destruction of the liquid air produced Moreover under the most favorable conditions the yield of this machine is hardly more than 0 2 liter of liquid air per horse-power hour

For this reason M Claude has been led to modify the process in the following way which I shall endeavor to explain A part of the cooled current of air compressed to 40 atmospheres is deflected before it arrives at the expansion cylinder This air under a pressure of 40 atmospheres is led into a chamber (liquefier) cooled by the gas of the original current which has been expanded in the auxiliary motor Thanks to a pressure of 40 atmospheres the deflected gas is liquefied in this latter chamber at a temperature no longer of 190 deg C as was the case in the original process where liquefaction occurred at the limit of its expansion but at — 140 deg C Further more the expanded air which circulated in the liquefier is heated up and arrives in the economizer no longer at 190 deg C but at about —130 deg C It cools the gas in the feed conduit less so that this gas arrives in the auxiliary motor at a temperature of about —100 deg C Its expansion takes place therefore under more favorable conditions and liquefaction by expansion is less to be feared

By thus substituting liquefaction under pressure for spontaneous liquefaction by expansion M Claude had brought his process of recovering the energy of expansion down to a practical basis With machines utilizing an exterior air compression capacity of 75 horse power the yield of this process becomes as high as 0 7 liter of liquid air per horse power hour

This idea can be carried still further however The air which arrives at the auxiliary motor at a pressure of 40 atmospheres and a temperature of about 100 deg C can be subjected in expansion to a too great drop in temperature To avoid the recurrence here of the difficulties encountered in the original process all that has to be done is to carry out the expansion by degrees in several auxiliary cylinders The air of the first expansion can circulate about a first liquefier into which is led a deflected portion of air from the feed circuit in a cold and compressed condition The circulating air is warmed up and goes on to be expanded in a second auxiliary cylinder This air from the second expansion is sent into a second liquefier similar to the first and is finally led into the economizer In practice the two liquefiers are not distinct the two currents of air after expansion merely circulate about different sections of the same liquefaction apparatus M Claude has given the name of compound liquefaction to this last process It marks a new and important step in the technique of the liquefaction of air In machines of the type described above the yield of liquid air by the application of compound liquefaction is as high as 0 85 liter per horse power hour

Liquid air promises to be the sole industrial source of oxygen and nitrogen The manufacture of these two gases at a very low price is a problem the solution of which has a very great importance in metallurgy and in the fertilizing industry How we can derive these gases from liquid air is a problem that I am now going to consider

Oxygen and nitrogen are two bodies whose critical points are slightly different (—118 deg C and 18 atmospheres for oxygen —146 deg C and 33 atmospheres for nitrogen) The vapor tension curve of nitrogen is below that of oxygen At a like temperature, below the lower of their critical temperatures the two gases, considered separately, liquefy at very different pressures The liquefaction of air—that is to say, a mixture of these two gases—presents, however some peculiarities which are worth mentioning

If at a sufficiently low constant temperature, T, air is compressed in a closed chamber the following phenomena may be observed

(1) At a predetermined point of pressure P_0, a first drop of liquid appears This is what after Duhem,* we call the dew point

(2) If at the constant temperature T the volume of the air is diminished the pressure increases at the same time the quantity of the liquid phase grows larger If this increase of the pressure is continued all the air will pass into the liquid state the values for P and T for pressure and temperature at that instant characterizing what Duhem has denoted the boiling point

(3) The dew and boiling points obtained at different temperatures trace in the system P O T on one hand the dew line and on the other the line of boiling of the gaseous mixture considered

(4) For each system of values (T P) of temperature and pressure the two phases liquid and gas are in a state of equilibrium in this state the composition of the two phases is different

(5) The percentage of oxygen (the more easily liquefied element) in either liquid or gaseous phase we will term the content of this phase

The content of the liquid phase in a sate of equilibrium is always greater than the content of the gaseous phase At a constant temperature when the pressure is increased the contents of the two phases liquid and gaseous continue to diminish till the mixture is completely liquefied Thus when air is liquefied (volumetric content 21 per cent oxygen) the first drop of liquid contains oxygen and nitrogen and its content is 47 per cent This content continues to diminish as the volume of the liquid phase increases A liquid with 34 per cent oxygen can only be in equilibrium with gas of 12 F per cent oxygen But as long as there is a gas phase its content is considerably above zero C It remains above 7 per cent

It can be readily seen therefore that if the two phases liquid and gaseous formed by the progressive liquefaction of air are maintained in contact it is impossible to prepare gaseous nitrogen of a sufficient degree of purity

It is a different matter however when under constant pressure conditions the liquid phase is eliminated as fast as it is produced We find ourselves here in the presence of a phenomenon inverse to that observed when liquid air is distilled under constant pressure In such a case the contents of gaseous and liquid phases increase continuously The phases both tend toward a composition of pure oxygen At the same time the temperature of boiling rises from a value in the neighborhood of that of pure nitrogen to the boiling point of pure oxygen Inversely, if we progressively condense air under constant pressure eliminating the liquid phase as fast as it is formed there are obtained gaseous residues less and less rich in oxygen at the same time the temperature of condensation becomes lower and tends toward the boiling point of pure nitrogen at the pressure employed We obtain therefore much more rapidly than in the process considered above a gaseous mixture richer in nitrogen To obtain a gaseous residue practically free from oxygen however it is necessary if this method is used to almost completely liquefy the air

A much better result is obtained by the use of a device designed by M Claude which he calls a retour en arrière (reflux apparatus)

Let us imagine that the liquid after separating from the gas encounters a gaseous mass richer in oxygen The liquid is colder on account of the large proportion of nitrogen it contains A part of the more condensable oxygen of the mixture will therefore be liquefied and take the place of nitrogen which will vaporise Thus by circulating in opposite directions a liquid and a gas having different contents there is obtained on one hand a liquid very rich in oxygen and on the other practically pure gaseous nitrogen This process utilizes, moreover a large amount of air which never needs to be liquefied

* Translated from the Smithsonian Institution Annual Report from the Revue Générale des Sciences pures et appliquées Paris twentieth year No 5 March 15th 1909

† For a description of this machine see F Mathias La préparation industrielle de l'air liquide et ses applications les gaz liquéfiés *Revue générale des Sciences* vol xi 1901

‡ Readers desirous of obtaining the details of Claude's processes will find an account of them in the following G Claude Air liquide Oxygène Azote Paris H Dunod and E Pinat 1909

* Duhem: Traité de Mécanique chimique, vol. IV, Chap. 4, Paris, Hermann

M. Claude has utilized this principle of reflux in the following way. A sort of small tubular boiler is arranged so that its axis is vertical. The tubes are surrounded on the outside with liquid air and into the lower ends of these tubes is led a current of cold compressed air. This liquefies progressively, giving liquids poorer and poorer in oxygen; these liquids in falling into a receptacle below encounter gases rich in oxygen and produce the gradual dilution, the principle of which we have described. There finally separates out at the top of the group of tubes practically pure nitrogen, while liquid with a high per centage of oxygen is continually drawn out of the lower part.

A second obstacle remains still to be overcome. Instead of air supercharged with a volumetric content of 47 per cent oxygen, it is necessary to obtain practically pure oxygen. This can be attained thanks to processes of rectification based on those employed in the alcohol industry. In such a process there are two circulating streams inside of a column, one from the bottom to the top of practically pure oxygen gas, and the other from the top to the bottom of liquid containing a large proportion of nitrogen. The latter being colder condenses the oxygen and allows its nitrogen to escape in a gaseous form according to the process which we have seen developed in connection with the reflux apparatus.

The apparatus for this purpose is again composed of a sort of tubular boiler with its axis vertical. At the upper end it continues into a column with condensing shelves such as is used in the alcohol industry. The vertical tubes of the boiler are surrounded by practically pure oxygen and into the interior of these tubes cold air is introduced at a pressure of about five atmospheres. As previously explained this air becomes liquefied, giving in the lower part of the boiler liquid air surcharged with oxygen and in the upper part practically pure gaseous nitrogen. This is carried through the liquefied oxygen and in turn becomes liquefied. The superoxygenated liquid is carried up (through a tube) by its vapor pressure and flows continuously into the central part of the rectification column. The liquid nitrogen is conveyed to the summit of the column. The oxygen vaporized in the tubular chamber on account of the condensation of the air in the interior of the tubes encounters in the rectifying column liquids richer and richer in nitrogen; there falls back in the still consequently liquid oxygen in a practically pure state, while pure nitrogen separates out at the top of the column. The quantity of liquid oxygen which falls back into the still is greater than the amount which vaporizes and ascends into the rectifying column. This excess of oxygen is drawn off and led by way of an economizer to meters and to apparatus where it is used.

Such is the principle of the Claude method for the production of practically pure oxygen and nitrogen. The Linde method differs only in certain of its details. The Bardot factory, which works the Linde process at Aubervilliers, at present produces about 50 cubic meters of oxygen per hour. The Société de l'Air Liquide, which uses the Claude process, has placed in operation apparatus capable of producing 100 cubic meters of oxygen per hour. The yield is about one cubic meter of pure oxygen per each horse power effective on the shaft of the compressor in apparatus of 50 cubic meters and about 1.19 cubic meters for those of 100 cubic meters capacity.

This method of reflux has also made it possible for M. Claude to extract pure gases such as neon and helium from the air. The apparatus enables him to extract as a by-product of the industrial manufacture of oxygen and nitrogen a mixture of nitrogen with at least 50 per cent of neon, helium and hydrogen. To accomplish this the gaseous residues which are strongly resistant to liquefaction are drawn out in the proportion of 6 000 liters per hour for an influx of air of 3 500 cubic meters from the lower parts of a tubular system cooled by liquid nitrogen. By the conjunction of a pressure of four atmospheres and a very low temperature all the liquefiable parts are condensed and the gaseous residue, if the quantity is well regulated, consists of an almost pure mixture of neon and helium.

The liquefaction of air is not the last obstacle which men of science have overcome in the field of gas condensation. Helium, which long resisted the efforts of all physicists, has finally been liquefied by M. Kammerlingh Onnes in the cryogenic laboratory at Leyden* whose installation admits of the attainment of a range of temperatures from 0 deg. down to —253 deg. C. By cooling down helium by hydrogen boiling in a vacuum and suddenly expanding the gas compressed to 100 atmospheres the Dutch scientist has obtained a transparent colorless liquid boiling at —269 deg. C. with a density of 0.154. The critical constants of helium appear to be in the neighborhood of —268 deg. C. and three atmospheres.

Thanks to the admirable scientific equipment of the laboratory at Leyden, M. Jean Becquerel has been able to study at very low temperatures the phenomena of liquid absorption and emission, such as the magneto-optic phenomena in crystals and solidified solutions. This work of Becquerel, so important in its significance, bears on the following points:

(1) Observation of the influence of variations of temperature on the abnormal phenomena of absorption and dispersion. Laws of the variation of the width of bands and the existence for each band of a maximum absorption. Calculation of the number of corpuscles producing absorption. Spectral analysis at low temperatures.

(2) Study in crystals and solutions of a phenomenon of the same nature as the Zeeman effect. Invariability at varying temperatures of period changes produced by magnetism. Observations at low temperatures of phenomena showing the variation in stability of vibrating systems where their period is modified.

(3) Rotary magnetic polarization at low temperatures. Explanation of rotation in the vicinity of the band of absorption. Generalization of the phenomenon of rotary magnetic polarization. Extension of the phenomenon to biaxial crystals. Joinder produced by a magnetic field of two principal vibrations normal to the lines of force. Experimental proof of the existence in a body submitted to a field normal to a luminous ray of a longitudinal component of electric force.

As M. d'Arsonval has so aptly pointed out in his paper at the close of the conference, the study of these phenomena gives new results on the nature, the movements and the number of the electrons which produce absorption. It contributes to the extension of our knowledge as to the ultimate constitution of matter.

The study of the phenomenon of magnetic saturation at low temperatures permits, as M. Pierre Weiss has remarked, of the determination of the magnetic moment of the molecule.* This quantity is fundamental in the expression of the law of corresponding magnetic states, a law analogous to that of the same name which governs the compression and dilation of bodies.

A study of such importance as the molecular modification of bodies is rendered possible by the well known fact that electric conductivity increases as the temperature is lowered. The creation of powerful magnetic fields by simple coils cooled down and traversed by very intense currents permits the realization of the atom and allows it to be transformed and its movements modified.

For this reason the first section of the congress adopted the following resolutions presented by Messrs. Jean Perrin, Mathias and Kammerlingh Onnes:

(a) In view of the extreme importance which is attached to the modification of atoms and the possibility of attaining this result by means of an intense magnetic field (a possibility which the Zeeman phenomenon has already demonstrated) the congress offers the resolution that the nations should unite for the construction of a great electro magnet without iron, the efficiency of which shall be increased by an intense refrigeration.

(b) In view of the admirable scientific equipment of the cryogenic laboratory at Leyden and the hospitable offer of welcome made by Prof. K. Onnes to the investigators of all nations, the physicists present at the first section of the Congress of Refrigeration express the following resolution: That the governments of the nations represented at the congress should furnish necessary assistance to permit physicists to carry out at the cryogenic laboratory at Leyden researches with regard to physical properties at very low temperatures.

"(c) The congress resolves that an international association shall be founded to further such study, scientific or otherwise, an association with its head quarters at Paris, which, while aiding the already specialized fields of research, shall undertake the study of the whole domain of low temperature.

In view of the high degree of interest which attaches to the carrying out and co-ordinating of scientific research in the field of low temperatures, the congress resolves that the bureau of section A shall be charged with the organization of a permanent international association for the study of all scientific questions relating to low temperatures.

II. REFRIGERATING MEDIA.

In the storehouses where at the present day food stuffs are preserved by refrigeration, low temperatures are obtained by the vaporization of the following liquefied gases: Ammonia, sulphurous anhydride, carbon dioxide and methyl chloride.

The liquefaction of these refrigerating agents may be attained (1) by means of a compression pump (compression machines); (2) by means of a solvent such as water (absorption machines). In the compression machines, which are at present the most widely used in the refrigerating industry, the gas liquefied in the condenser or liquefier passes by way of a regulating cock into the refrigerating chamber or evaporator; there it is vaporized by a pump which draws out the vapor, compresses it and sends it to be liquefied again in the condenser. In the absorption machines there is also a liquefier connected with a refrigerating chamber by a stopcock. The compressor —the aspirating and force pump— is replaced (a) partly by an absorber in which the vapors from the refrigerator (in these machines as a matter of fact ammonia gas is used) are dissolved in water; (b) partly by a boiler where the heated ammonia solution gives off ammonia gas. This is again condensed in the liquefier.

The utilizable effect of such a machine or its refrigerating power is measured by the quantity of heat absorbed in the refrigerator during a certain period, or, as is sometimes said, the quantity of cold developed in the refrigerator during the same period.

As M. Barrier has remarked, this power varies widely with the temperature of the refrigerating agent at the condenser and at the refrigerator. The specification of these temperatures affords the only means of comparing with any exactitude the claims of machines made by different constructors and the only means of avoiding difficulties in commercial contracts and exchanges.

Furthermore different countries adopt different units to express this refrigerating power. In France and Germany they express the refrigerating capacity by the number of kilogram calories absorbed or kilogram frigories (negative calories freed) per hour). In England and in the United States they prefer to measure the refrigerating capacity for a day of 24 hours and express it in tons of refrigeration, but in England the refrigeration ton is equal to 81 300 kilogram frigories, while the refrigeration ton in the United States only amount to 72 600 kilogram frigories. Lastly, moreover, in the United States the constructors and consulting engineers often express the cooling capacity of the machines in gallon degrees per minute, the temperature of the refrigerator being kept at 10 deg. F. (—23.3 deg. C.). Such a unit is equal to 110.24 hour frigories.

It would be very useful to adopt for the refrigeration capacity and for the different quantities which have to be considered in the refrigeration industry a perfectly coordinate system of units like that used in electricity.

M. Maurice Leblanc has submitted a very carefully studied out report on this subject. But in view of the opposition of the English speaking delegates, the question does not seem to be fully settled, and Section II has passed the following resolution:

That an international scientific commission composed of theoretical and practical specialists in the subject of low temperatures shall be appointed to consider values, units and notation suitable to the refrigerating industry, and shall report at the next congress. It is to this commission that the proposition of M. Kammerlingh Onnes to give the name of Carnot to the unit of entropy has been referred.

This same commission has been likewise charged with the duty of fixing the temperatures of condenser and refrigerator which shall be adopted so that the refrigeration capacity of a machine may be defined. Section II has only been able to take the following resolution on that subject: That the normal capacity of a refrigerating machine shall be defined by the number of thermal units it can produce in an hour at the given temperatures of the gas at condenser and refrigerator, the choice of these temperatures and thermal units to be left to the determination of the international commission charged with the selection of units.

As a corollary to these resolutions it is likewise desirable to unify the methods of testing refrigerating machines. For this reason the following resolution has also been adopted by Section II: That the question of simple, practical and uniform methods of testing refrigerating machines, based on the units defined by the international commission and applicable to the different types of machines and to different circumstances of installation, shall be made a subject of study with a view to international agreement.

(To be continued.)

From the *Mineral Survey of Ceylon*, the initial stage of which may now be regarded as practically completed, it is clear that the island contains, in addition to gem stones, a number of minerals of commercial importance, of which only graphite, mica and thorianite are at present worked. The mining of graphite is on a large scale and in some cases is under European supervision. This mineral is an important article of export. Mica is only mined to a small extent by primitive methods, but there is room for further enterprise in this material now that it is known that much of the Ceylon mica is of value for special purposes. Thorianite is a new mineral discovered as a result of the operations of the survey. Comparatively large quantities have been profitably exported in recent years and utilized in this country as a source of the thoria used in the manufacture of the incandescent gas mantle.

* Mathias: Le Laboratoire cryogène de Leyde. Revue générale des Sciences, Paris, Feb. vii, 1896, p. 381.

* P. Weiss: L'hypothèse du champ moléculaire et la propriété ferromagnétique. Revue générale des Sciences, February 15th, 1908.

Modern Deluge Sets for Fire Extinguishing Service

Heavy Streams and How They Are Handled

By Frank C Perkins

It is the criticism of many fire experts that in the past altogether too little attention has been given to the water stream either as regards character body or manipulation The chief thought has been to shorten the time required to reach the fire which has been cut down from minutes to seconds by the introduction of modern improvements It can not be denied that in this respect progress has been along the right lines

But this much being accomplished the next step should be the adoption of a system of producing and handling streams which would with equal promptness stop the fire Our illustrations show a number of devices designed especially with this object in view and aiming to produce a stream of great compactness and carrying power

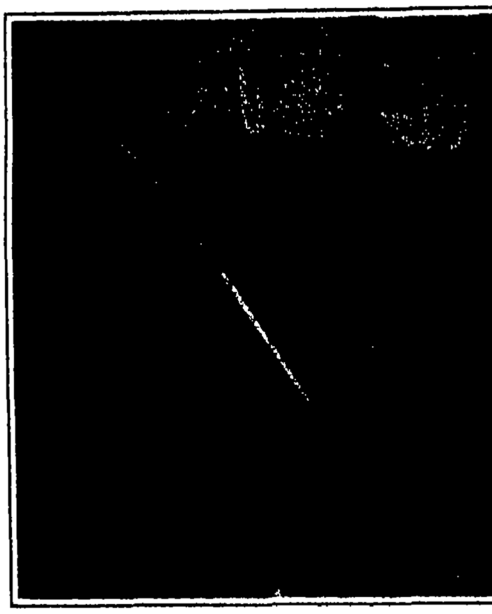
It is well understood that the stream of water in order to be effective must be increased in size and distance as nearly as possible in proportion to the extent of fire since heavy streams only are effective on large fires Many people are not aware that such heavy streams can be produced from ordinary pressures by the employment of proper nozzles for the purpose

Almost every fire department is equipped with chemical extinguishers and nozzles giving ordinary sizes of streams such as are indispensable for ordinary fires but in many cases they are not equipped for coping with the greater disasters caused by fire While ordinary fires have been provided for exigencies of great conflagrations to which are due the heaviest losses in this country have not been met

With the latest nozzle system for producing and handling powerful streams it is possible for every fire company to have at hand at a very small expense all sizes of streams whereby immediately to meet any conflagration with a stream of water in proportion to the size of the fire

These modern deluge sets are very light and compact and can be put in operation at a moments notice the 3½ inch reducers being provided with the same thread as the regulation 2½ inch hose thread in the department so that upon reaching a fire the deluge set can be placed upon the line of hose at any point desired the ordinary 2½ inch line of hose for inside work can then be extended to any place desired by simply turning off the deluge nozzle tip If the firemen are driven out of the building the 2½ inch line of hose can be disconnected from the deluge line the nozzle tip replaced and the deluge stream with all its force then projected into the fire without loss of time With these modern deluge nozzles any section of the 2½ inch hose in the fire department can be adapted to deliver as large streams as may be profitably used on 2½ inch hose.

A special holder is provided for handling these heavy streams taking all the weight and reaction from the man at the nozzle so that he is able to direct the stream without difficulty under pressures which



TWO INCH STREAM FROM 150 POUND HIGH PRESSURE SERVICE

without these devices would require several strong men to control

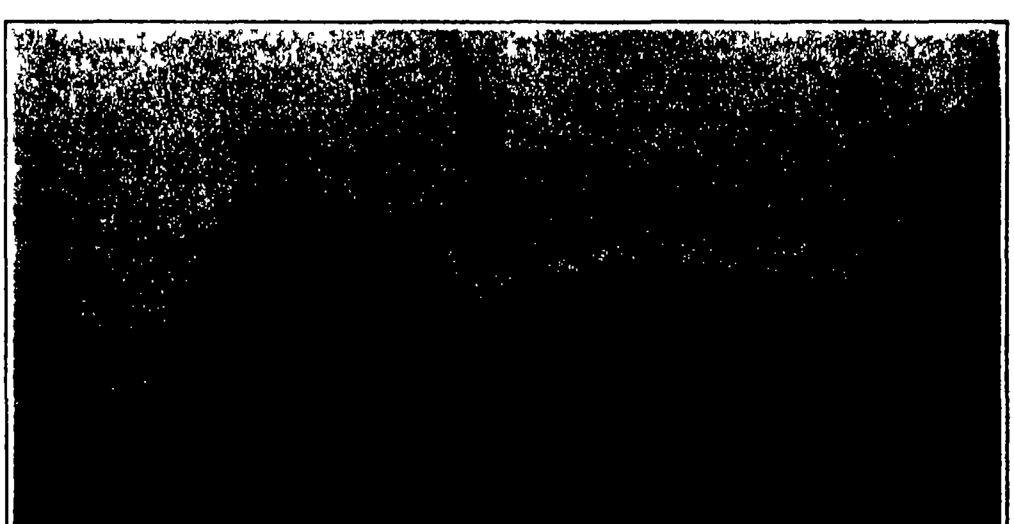
It will be readily seen that when firemen have at their command the means of adjusting the stream to the conditions of the fire a principle will have been adopted which will more than double the efficiency of the fire service and which will reduce fire losses and insurance rates by the millions In fact this change has already in part taken place

There has been devised a special reducer which turns directly on the male coupling of any section of hose The construction of this reducer is such that it takes all twist and whirl from the stream and brings water friction to a minimum The water leaves the nozzle in a straight solid stream which carries nearly all the water undivided to the end A stream without solidity is deficient in carrying power and almost worthless against a strong wind

Our accompanying full page illustration shows a 1¾ inch solid stream issuing from the improved type of nozzle in use at Manchester, New Hampshire. In the small view is seen a 2-inch stream thrown from a high pressure service of 150 pounds, the nozzle being supported upon a simple holder and platform, while two of these devices are shown in service in our last engraving one nozzle throwing a 2½ inch solid stream from a gravity hydrant at a pressure of 85 pounds to a distance of 337 feet while the other nozzle is throwing a 1½ inch stream from the same hydrant

The efficacy of the hose-holder has been amply proved It is quite possible for a small child to direct and control the stream from a hose equipped with this holder though the jet of water issuing therefrom be so powerful as under ordinary conditions to severely tax the strength of an able-bodied man

By such careful attention to nozzle design and the details of hose equipment it should be possible to do a great deal to advance the present practice of fire fighting and to save the community much of that loss which is caused annually by the destroying flame



ONE OF THESE NOZZLES IS THROWING A 2½ INCH STREAM TO A DISTANCE OF 337 FEET THE OTHER IS A 1½ INCH NOZZLE BOTH ARE ON AN 85-POUND HYDRANT

MODERN DELUGE SETS FOR FIRE EXTINGUISHING SERVICE

The Function of Soap in Insecticides

Some iteresting researches upon insecticides are reported upon by Messrs Vermorel and Dantony of Paris There are two general classes of insecticides, those which act as poisons on the food of the insect and others of the external kind which kill the insect by simple contact. It is the latter which are considered by these authors One of the essential points to be borne in mind in the making up of such preparations is the necessity of providing for an intimate contact with the insect In order to wet a given body in the best way a liquid must be chosen which has a low surface tension However the authors show that with oleate of soda (soap) the same wetting effect is produced by the addition of 5 per cent to the solution as of 0 1 per cent The soap need not be used nearly as strong as is commonly supposed Solutions of 1 in 1 000 are as efficient as those of 50 per 1 000 For hard water a little carbonate of soda should be added A very cheap mixture is to use with flowers of sulphur one per cent of soap and the same amount of carbonate of soda and we have a product which wets instantly Thus with the usual dose (20 pounds sulphur per 100 gallons of water) the solution needs to contain but 2 in 10 000 of soap They find that alcohol is not needed here to increase the moistening action. The major part of coleopters and grape vine insects are instantly wet with 5 per 10 000 soap solution Insect webs are moistened by 1 in 1,000 solution

Mirage in the Metropolis

The London *Times* publishes a letter from Mr H Thompson Lyon describing the occurrence in the heart of London of an optical phenomenon that one associates with burning deserts and barren plains, rather than with the streets of a great metropolis Mr Lyon writes

"I witnessed this afternoon at a quarter to 3 o clock a remarkable example of the mirage on the north side of Grosvenor Square The whole surface of the roadway appeared a sheet of water My first impression, before I realized what the phenomenon was, was that a water main had burst and flooded the road On approaching closer the water broke up into pools and then disappeared altogether There was no one about except the policeman on duty and he would not believe me until he had gone up to the spot, that the road was perfectly dry He called my attention to the disturbance of the heated layer of air by the motor cars which exactly reproduced the effect of wheels splashing through shallow water I have frequently seen the mirage in the desert of the Sudan, but I have never observed a more realistic exhibition It would be interesting to learn if other instances of mirage have been observed in this country"

In reply to the query at the end of this letter, the Quarterly Journal of the Royal Meteorological Society states that a mirage was observed in London by Dr Wollaston, F R.S., in 1797

In attempts at reforestation of the treeless areas of our national forests by the Forest Service it was found that on an average half of the seed was dug up and eaten or carried away by mice and chipmunks. Attempts to poison the animals, however, have proven very successful Oatmeal mixed with strychnine and water, or wheat coated with hot tallow mixed with strychnine as a protection against rain or moisture, proved very effective. The poison should be distributed several days in advance of the seeding.

A Remarkable High Power Electric Locomotive

A 1000-Horsepower Plant on Wheels

OUR illustrations present views of a very interesting electric locomotive in operation on the Wiesenthal bahn in Baden. The weight of the locomotive is 66½ tons, it measures 43½ feet in length and 10 feet in width The adhesion weight is 42 tons There are six driving wheels of 4 feet diameter coupled to the elec tric motors by connecting rods with 20-inch stroke The smaller wheels at the leading and trailing end are 2 1/3 feet in diameter and the total wheel base is about 30 feet the fixed base of the drivers being 11½ feet.

The locomotive carries two 500 horse-power motors giving a total output of 1,000 horse-power on normal load with a maximum draw bar pull of somewhat over 10 tons. It makes 42 miles an hour hauling a train of 12 passenger coaches with a seating capacity of 51 each (aggregate weight 230 tons) or 27 to 30 miles an hour taking 15 to 20 freight cars (500 tons) The motors are of the multipolar type and are capable of giving 800 horse-power each in an emergency

The power is supplied by the Rheinische Kraft werke in August at 10 000 volts and 15 alternations per second. The locomotive was built by the firm J A Maffei of Munich and is giving full satisfaction One of the heaviest grades on the line between Basel and Zell figures about 1 100 and is negotiated without the slightest difficulty

Are Time and Space Infinite?

THE question proposed above forms the subject of a discussion which has appeared in *Popular Astronomy* in particular the affirmative answer is ably sus tained by C H Ames from whose plea we quote some of the most striking passages

'Every one recognizes that a finite space implies or presupposes larger space to exist in So on reflec tion just as truly does its environment As we pass from one space to another we are still in space and all finite spaces are parts of space itself— the all comprehensive and necessary reality which makes finite spaces possible

Hence space is limited only by space i e self limited i e universally extended and infinite There is and always must be space" beyond any and all spaces and when we say always must be we have the true undeniable and perfectly satisfac tory thought of the infinite Why do we unhesitat ingly say and always must be? This brings us to the most important distinction which it is possible for the mind to make and the one which when clearly perceived will solve a vast number of knotty prob lems and prove an emancipation of the mind from the unwelcome tyranny of one of our faculties which yet seems to so many persons to be unescapable

It is true that most of the thinking of mankind is what might be called image thinking It may even be admitted that most of it must be of this kind and not only accompanied by but in a sense dependent on the image the mind makes of imagable things

The question is whether there is another kind of thinking and a superior kind which whether *accompanied* or not by images is not in any sense *dependent* on them for its cogency and reliability It is certain that there is, and that even the ordinary and perhaps not very reflective man makes not infrequent use of it, as, for example when he says of a repeat ing decimal "and *so on forever* We say that two and two are four We hold the terms of this state ment clearly in mind and cannot frame a doubt of its certitude But we quite as confidently affirm that two quintillions and two quintillions are four quintillions What are the grounds of our certitude in the second case? We realize that it is our insight into the na

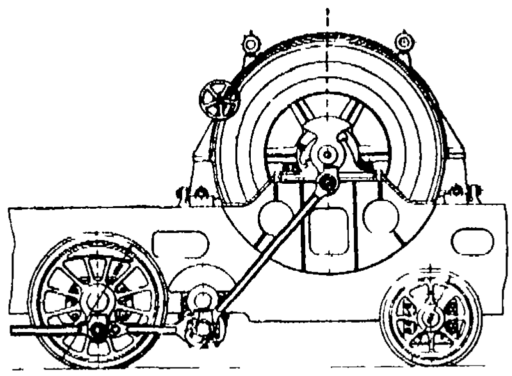


FIG 2—DETAIL VIEW SHOWING COUPLING OF MOTOR TO DRIVE WHEELS

ture of the case In other words it is our direct in sight into reason on which we rely and not at all on our power to envisage or imagine the separate units of this stupendous sum

Moreover we know that the truth we have so positively stated not only is true now but we are equally sure that it always was and always will be true and that we have here a regal and transcendent power of the mind of a wholly different order from that which depends on the power to create images which in order to *be* images *must* have borders and limits and must from their very nature be finite

Thus we may know thoroughly the *nature* of not *only* the finite but *also* the infinite *It is the power* of reason as contrasted with that of imagination The mind then is capable by the insight of reason of knowing that which the imagination from the na ture of the case is utterly powerless to cope with It sees the infinite is never the indefinite but the *self* limited and that this is a positive and satis factory result The indefinite is never the infinite though almost universally it obtrudes itself when the infinite is spoken of The indefinite is when seen correctly the *not yet defined* but that which for all that we know may yet sometime be defined,

But the true infinite of which we may have any number of examples and of which we may make constant and most important use is never of that kind Bearing its definition and nature constantly and unswervingly in mind we may affirm with ut most confidence and positiveness that both space and time are *truly* infinite

The mental protest which the imagination instantly makes is *only* the protest of the imagination which not only *may* be but *must* be set aside as impertinent and meaningless in the light of our higher insight

The effort of the imagination to find an end to space or a beginning to time may be seen from the outset to be futile In such effort the imagination as Herbert Spencer truly says sinks exhausted as we know it was doomed to do and its effort is not sublime but merely tedious and foolish and in no wise throws doubt upon the deliverance of reason or presents any dilemma in regard to it

If one should ask the shape of space whether spherical or otherwise his question dissolves in ab surdity when he realizes that he is thinking of space not as infinite as we know it must be but as finite a space requiring larger space of the old fashioned sort, to exist in and hence he is a victim of his imagination and can be emancipated from this ty ranny only by reliance on his reason What is true *of space in this regard is equally true of time* as will be readily seen Space and time then are truly and positively infinite despite the protest of the imagination

In the light of this thought the difficulty found with the thought of time and space disappears

Professor Pickering has said If it is difficult for us to imagine infinite space it is still more so to com prehend infinite time As we go back eternally through the ages how is it possible for there to be still an infinity of time before that? Yet we cannot conceive of an actual day or instant before which time did not exist

We see that in these few lines Pickering has used the terms imagine comprehend and conceive as interchangeable and without difference of meaning It is therefore not surprising that he is led into men tal tangles in which he has recourse to such gro tesque and as Herbert Spencer says only verbally intelligible expressions as those relating to time and space so curved that they return into themselves

It is the contention of this article that the trouble with the notion of infinite space is but the protest of the imagination and therefore negligible and that therefore the recourse to notions of a curved space and even a curved time of such nature that if we could go back far enough into yesterday we shall arrive at to morrow is as needless as it is fantastic and absurd

* Dr August Schmauss has been appointed director of the official meteorological service of Bavaria suc ceeding the late Fritz Erk

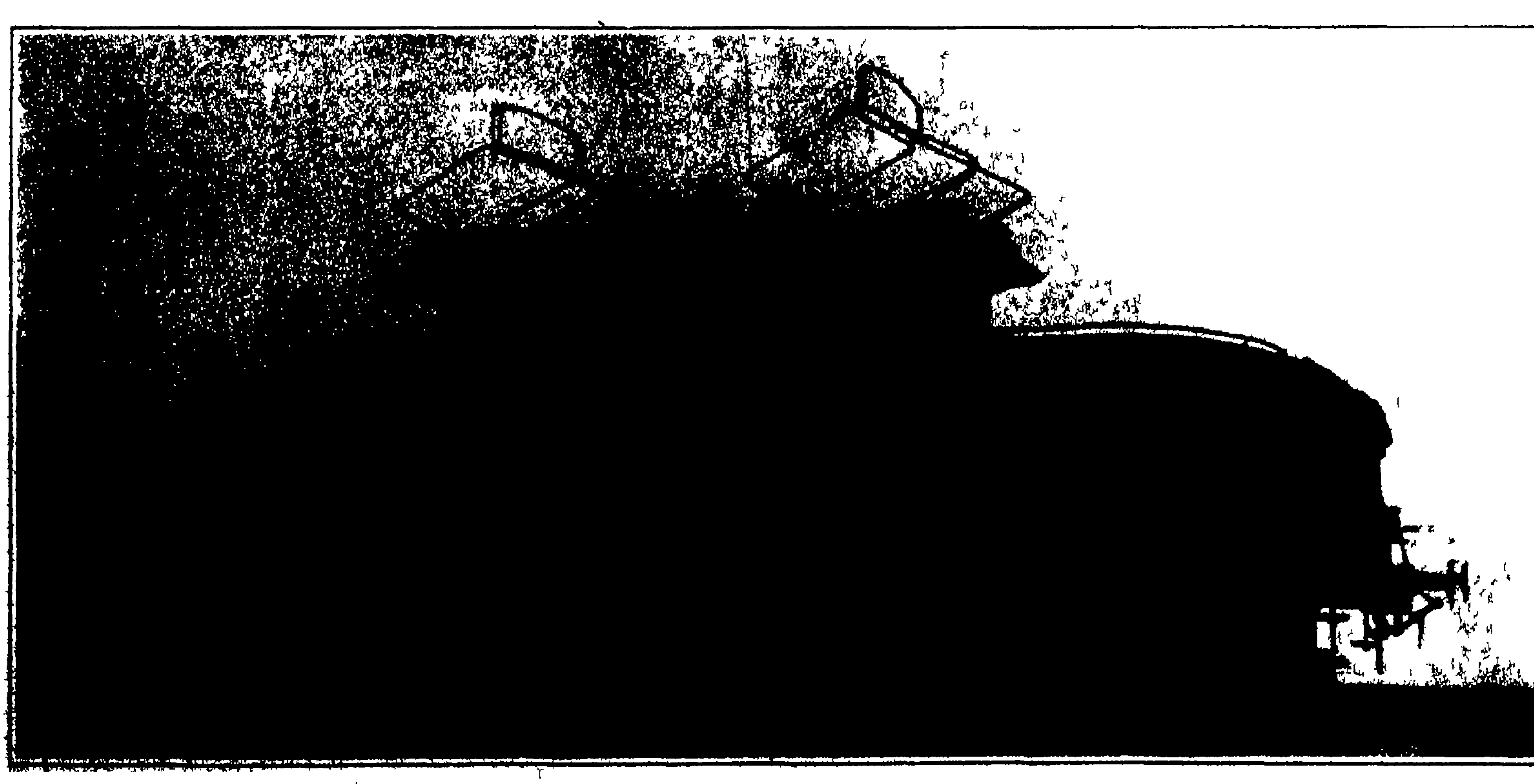


FIG. 1—A NEW ELECTRIC LOCOMOTIVE ON THE WIESENTHALBAHN BADEN

The American Navy*

Its Material and Its Personnel

By George von Lengerke Meyer, Secretary of the Navy

It is not perhaps generally known that Lincoln's military activity during the Civil War included naval operations as well as military operations on land. His orders and instructions to commanders of joint expeditions required the most perfect co-operation. He did more than merely approve plans submitted to him; he originated many of them. His mind readily solved most of the war problems submitted to him though the men and means were not always available for success.

Lincoln had the greatest confidence in the integrity of Hon. Gideon Welles, his Secretary of the Navy, and in the efficiency and ability of Captain Gustavus Vasa Fox, the Assistant Secretary of the Navy. Through the latter he maintained close relations with all naval operations.

Throughout the war Lincoln's custom was to spend a portion of every evening with Captain Fox in the telegraph office at the Navy Department and through his relations with him and the Secretary of the Navy he was in close touch with practically every detail of naval operations of the Civil War, including all independent and co-operative movements, and he clearly defined the relations between the naval and military services as strictly co-operative rather than subordinating one to another.

Lincoln is quoted as saying: "The Mississippi is the backbone of the Rebellion. It is the key to the whole situation. While the Confederates hold it they can obtain supplies of all kinds, and it is a barrier against our forces."

Lincoln's personal interest in Farragut's campaign was so great that when the Admiral hesitated about ascending with his ocean-going vessels from New Orleans to Vicksburg, Lincoln sent him through the Navy Department imperative orders to proceed up the Mississippi to meet the fleet of the Mississippi River Flotilla from above.

His admirable judgment is evident in all his orders regarding naval affairs during his entire administration. While entirely ignorant of technical and tactical details, his power of logically arranging groups of facts gave him a clear insight, and better still, real foresight in all larger strategical questions.

In Lincoln's time the largest ship was the Niagara, a screw vessel of 6,000 tons. Her complement was 30 officers and 400 men. No gun of the type used on vessels from 1861 to 1865 fired a projectile that could penetrate the armor of the modern battleship.

The Monitor, completed in 1862, was the first step toward the modern dreadnought. The first dreadnought, launched in 1906, has a displacement of about 18,000 tons and a battery of ten 12-inch 45-caliber rifles. The battery of the Monitor consisted of two eleven-inch smooth-bore guns firing projectiles weighing 170 pounds. She had a displacement of about 1,000 tons and a draft of 12 feet. Though smaller than the Merrimack, she was of superior strength on account of her heavier guns and armored turrets. The Merrimack was of 4,600 tons displacement, covered with iron plate like a box, and had ten guns, including six nine-inch guns.

THE DREADNOUGHT TYPE CONCEIVED IN AMERICA.

It is not generally known that in the summer of 1903 the ideas of the all-big-gun ship was conceived in the American Navy, and a sketch was submitted for the consideration of the officers in attendance at our War College in Newport, R. I. This plan was discussed at the War College during that summer. In January, 1904, the General Board, having considered the suggested plans, requested the Department to direct the Bureau of Construction and Repair to prepare tentative designs for a battleship with a battery of twelve heavy turret guns. The letter was referred to this Bureau by the Secretary of the Navy with directions to prepare such design. In September of the same year the General Board asked to be informed by the Bureau of Construction and Repair how soon the tentative design would be completed, but the Bureau had been preparing plans for the South Carolina and Michigan on lines similar to those of the Connecticut with a mixed battery. Finally, in September, 1905, it proposed the all-big-gun design for these ships. In the meantime, however, England had been at work on the British battleship Dreadnought, the first of her type, which was launched in February, 1906. Had the worth of the suggestion for the Dreadnought type been appreciated, regardless of the fact that the idea originated outside of the design bureau, the United States would have had the honor not only of producing the Monitor, but also the first Dreadnought.

To give an idea of the strength of the modern Dreadnought, I will quote from an article by Professor Hollis of Harvard, printed in the February number of the *New York Engineering Magazine*. He says: "A single one of the American battle fleet lately returned from Europe, in the hands of the Confederacy would have destroyed the entire Northern Navy. Not a ship, or any combination of the ships then existing, could have remained on the blockade. The cost of a modern ship must therefore be contrasted with that of our entire navy in the past of only forty years ago, in order to get anything like a fair idea of what should be paid for new ships."

The enlisted force of the Navy in 1864 was about the same as it is to-day, while the number of vessels in commission was 683, with a displacement of 500,000 tons, as against 212 vessels in commission in 1910, with a displacement of 790,000 tons.

THE NAVY BEFORE AND AFTER THE CIVIL WAR.

The Navy to-day differs from that of twenty years ago not only in ships and guns but in men. Few people appreciate the fact that 96 per cent of the enlisted men to-day are American born, representing every State in the Union. They have not been seafaring men, but are young men of high intelligence from every walk in life. As soon as they are enlisted they are sent to a training station, where they are taught sanitary care, drilled in the necessary exercises pursuant to their vocation, and within three months are generally placed on a battleship or other man-of-war. Here they are developed according to their inclinations and ability in electricity, machinery, gun firing, and all requirements of a modern man-of-war to such an extent that when their enlistments expire they are a valuable asset to the country. The Navy increases their productive powers for times of peace and makes them a strong instrument for defense in time of war.

The duties of the officers have also changed materially. The battleship fleet, which is the navy, and to which the country would look in time of trouble, is composed of enormous ships which are floating power plants full of complex machinery. Consequently it is necessary that the officers should be versed in engineering as well as seamanship. Roosevelt once said every officer must be a fighting engineer. To command, or to be the executive officer of one of these great moving machine shops requires technical knowledge, executive ability, mental training, and a physical condition as nearly perfect as possible in order to be able to stand the strain and responsibility.

One of the most far-reaching acts of our former President, Theodore Roosevelt, was to issue an order directing our battleship fleet of sixteen vessels to encircle the globe. At the time the success of this movement was considered by many but not by him as problematical and hazardous. No such armada had ever attempted a similar voyage, and there were many critics at home and abroad who were skeptical and opposed to it. However, it was a stupendous success, with far-reaching results. It served as a messenger of peace instead of a menace to the world. It was received with enthusiasm and cordiality everywhere. It impressed the world with the power and skillful handling of the American Navy. The American people were proud of their ships and men, and pleased with the entire success of the cruise.

NAVY ORGANIZATION.

When I became Secretary of the Navy I found an organization dating back to the year 1842, when the expenditures were about eight and one-quarter millions of dollars and the number of sailors and marines were about eleven thousand. In 1842 but 29 vessels were in commission, with a tonnage of 30,000 tons.

In 1910 we expended approximately $135,000,000 for the Navy, had 57,000 sailors and marines, 212 vessels in commission, and a tonnage of nearly 800,000 tons.

I made it a point to study the reports of former secretaries of the Navy, of Boards of successful shop and shipbuilding organizations, and the great navies of other countries, and finally adopted in part the recommendations of a commission which had been appointed by Mr. Roosevelt. This commission was presided over by Justice Moody and included Admiral Mahan, Judge Dayton, the late Paul Morton, Rear Admiral Luce and Rear Admiral Folger. It was the report of this commission which the Swift Board appointed by me used as a basis for the reorganization which is in effect in the Navy Department at the present time. This organization is logical and successful, and the responsibility is now on Congress to make it statutory.

While I was before the Naval Committee recently arguing for two of the latest Dreadnoughts, it was suggested to me by one member that, as battleships' hulls with their steel construction did not become unseaworthy, instead of building a 30,000-ton battleship, we might reconstruct three of our 15,000-ton battleships to take the place of the one proposed. This member did not appreciate the fact that if the same old guns were kept on the smaller ships, the larger vessel with more modern guns and better armor and more speed could choose her own distance and annihilate the smaller vessels. But even if the reconstructed vessels had the best guns and the same speed as the large modern battleship, the three together could not be maneuvered with the facility that the one large one could. Thus the one large vessel could concentrate its enormous gun fire on the smaller vessels in turn and destroy them in detail.

To reconstruct and bring up to date is a costly and unprofitable undertaking. No one would think of reconstructing a locomotive or a street car after many years of service—then why a battleship, when the result is so poor.

The fleet, if kept up to date and with the proper military efficiency, is an insurance against war. As long as our fleet is efficient and of sufficient size we can be sure that we will not have war.

The object of the present organization in our Navy is to maintain the highest military efficiency, that is, a preparedness for war on the part of the fleet.

I have aimed to establish up-to-date business methods in the Department and navy yards. The result should be economy throughout the entire naval service, with the assurance that whenever a dollar is expended full value will be received.

In order to keep track of what is expended, a new system of bookkeeping has been established by which trial balances can be furnished monthly. This has not been possible heretofore. Cost accounting has been systematized so that hereafter comparisons can be made between the various yards. Stores have been consolidated from seven store accounts into one property account. The Naval Supply Fund is to be abolished and $2,700,000 is to be turned back into the Treasury for general use of the Government.

In navy yards there has been a logical division of work into the divisions of hull and machinery, a system adopted in our successful private shipbuilding plants as well as in the English and German navies. The abolition of the Bureau of Equipment has been recommended, its duties to be divided logically among the other bureaus. Congress has, however, neglected to do this as yet.

HOW THE NAVY DEPARTMENT CONDUCTS ITS BUSINESS.

The business of the Department has been grouped into four natural divisions, and assigned to each division is an experienced officer, who acts as an aid to the Secretary of the Navy. These aids keep him informed and serve as his expert and responsible advisors. They are the Aid for Operations of the Fleet, who attends to matters never before provided for systematically; the Aid for Inspections, who carries on a systematic and thorough inspection ashore and afloat, with the object of avoiding large expenditures on vessels which would not be a military asset after the money had been expended; the Aid for Personnel, and the Aid for Material, the last covering the material bureaus. With this organization, and the hopefulness inspired by the motto now adopted, that "The Fleet is the Navy—the Navy is the Fleet," we find to-day a healthy spirit of co-ordination in the navy and a zealous aim to get efficiency as well as economy.

Competitions have been introduced in the fleet not only in gun practice but also in the consumption of coal and the use of stores. This has resulted in a saving in expenditures and in even higher efficiency.

To give a brief idea of the improved administration of the fleet and the navy yards, the following is interesting:

The Paymaster General of the Navy, on comparing the cost of administration of the navy yards for 1910 and 1909, finds that if the gross charges had borne the same ratio to the productive work in 1910 as in 1909, the gross charges would have been proportionately greater by $3,166,307.

In 1909 there were 196 vessels in commission, and in 1910 there were 212. If the cost of maintenance per ship had been as much in 1910 as it was in 1909, the expenditures afloat, it is calculated, would have been increased $4,113,331.

The gain in administrative economy and operative efficiency of the navy may be indicated by adding these sums together, showing that but for better business

* Abstracted from an address at the Lincoln Day dinner of the Republican Club of the City of New York, Monday evening, Feb. 13th, 1911.

methods, $7,278 628 more would have been spent, in other words, the operating expenses of the navy have been reduced by that amount.

During the year in which this improvement has taken place the number of ships increased about 8 per cent the average number of ships actually in commission was increased about 11 per cent and the displacement of vessels was increased about 9 per cent

The power of motive machinery was increased about 16 per cent, and the average cruising speed of the fleet has increased from 10 to 12 knots without additional consumption of coal.

Thus greater efficiency has resulted with more economical administration

The indicated improvement in economical administration amounts to about 9 per cent of the total amounts expended for running the navy yards and ships or 6 per cent of the total expenditures for the entire year for all purposes

CONDUCTING THE NAVY ON A WAR BASIS

Ships are now moved in squadrons or fleets engaged in battle practice maneuvering and gun firing Everything is carried on as though war existed or might exist at any moment The principle being that to be prepared for war is to avert war

Our ships are giving strict attention to self maintenance and to keeping of vessels in repair by the enlisted men They only go to the navy yards for docking and for large repairs

In all these reforms and recommendations I have had the entire endorsement and hearty support of President Taft without whose aid and sympathy little could have been accomplished He also is very desirous and keen that we should build two battleships a year

With the opening of the Panama Canal the importance of the Caribbean Sea as a base of future naval operations will be realized It is the hope of the Department to have a naval base in the accessible and suitable harbor of Guantanamo Cuba which is some 700 miles from the canal and capable of harboring a fleet of fifty or more men-of war

It is important during battle maneuvers in peace or a period of real hostilities that a vessel should not be called upon to return two thousand miles in order to be repaired This can more easily and economically be done by the development of Guantanamo as a docking and repair station I have recommended to Congress that certain useless naval bases and yards should be abolished, bringing about a saving of about a million and a half dollars annually in maintenance for these yards alone Congress must assume the responsibility if this is not accomplished as it requires legislative action

It is the intention to develop Pearl Harbor San Francisco Bay and Puget Sound in order that after the Panama Canal has been completed the entire fleet may be maintained on the Pacific Coast

PRIVATE YARDS VS GOVERNMENT YARDS

At the present time Congress is in the midst of a discussion as to the method under which ships should be built—whether they should be confined to an eight hour limitation of labor not only in the Government yards where eight hour labor is the rule now but also in private yards It is interesting to note the extra cost involved and what a detriment it would be to the resources of the country if the private yards are to be driven to an eight hour basis just at the moment when our shipyards are successfully competing with the shipbuilding organizations of the great maritime nations We know that if the vessels of the building program recommended by the President were to be built in the Government navy yards it would cost about $20 775 000 whereas if built under present conditions of labor in the private shipyards without restrictions by an eight hour law there would be a saving of about five and one-quarter millions of dollars The battleship Arkansas which was launched last month at Camden N J was constructed and launched at a cost of four and one half millions or one and one half millions less than the limit of cost fixed by Congress The Florida building at the New York Navy Yard will cost $6 400 000 and its cost will exceed that of her sister ship the Utah (building at a private yard in Camden N J and launched six months ago) by $2 450 000

In the case of the new Texas a thousand tons larger than the Arkansas with the eight hour provision the Department was obliged to accept the one offer of $5 830 000 an advance in price over that for the Arkansas of $1 750 000 although the size had only increased a thousand tons It is estimated that the sister ship of the new Texas (to be called the New York) which Congress provided should be built in a navy yard (which means the New York yard), can not be built for less than $7 500 000 In other words if Congress will permit the New York to be built at a private ship yard a saving can be effected based on the estimate for the Texas even with the eight hour limit of labor of $1 650 000

WHAT THE NAVY MEANS TO THE NATION

The building of the American navy has brought about many advantageous results to the country Before the era of the white fleet (1887) a steel ship had not been built in this country The requirements of the Navy and the studies and aid of naval officers brought about the establishment of some of the great steel plants which are on such a basis to-day that they are able to compete successfully with the world The new Navy is responsible for the education development and training of a large class of men who enter our industrial world It has enabled a number of shipyards to exist which could not have continued but for the Navy These yards are invaluable assets to our country and are prepared when Congress sees fit to encourage our shipping to build the required merchant marine for the United States which will be a valuable adjunct to our Navy

All of us are anxious for universal peace and there are many who feel that it can eventually be brought about by an international supreme court We must bear in mind however that no court can be of any service unless its decrees can be enforced When the nations agree to an international court it is certain that five or six great nations will be obliged to maintain navies in order that the decrees of the court will be maintained It will be necessary that no one of these nations shall have a greater or more powerful navy than the combined navies of the other nation members of the court We may therefore feel sure that the American navy in the future under the most favorable conditions as to peace will have to exist It will have to be ready to do its share in the enforcement of the decrees of this court if established when necessary

With the certainty of an expanding commerce in the future with our surplus products carried to the world's markets and with our growing responsibilities in the region of the Panama Canal a strong navy will be a necessity

The Products of the Soap-nut Tree

By O W WILLCOX and M I RENTSCHLER

ATTENTION has recently been drawn to the Soap Nut the fruit of a tree indigenous in India and Algiers but recently introduced into Florida as a source of Saponine Extracts This is a substance applied to various uses e g as an addition to toilet soaps and other toilet preparations and as a foam producing material in carbonated beverages It is said to be also used by chemical laundries and cloth fullers instead of soap The material at present in most general use in this country for manufacturing saponine extracts is Panama bark (quillaya) Through the courtesy of Mr Moulie through whose efforts some 500 000 young soap nut trees have been planted in the United States we were enabled to secure a couple of pounds of the soap nuts produced by the only tree in America which has reached full maturity and through the courtesy of Schutz & Co of Hamburg we received two kilograms of soap nuts of which this firm is a large importer its supplies being drawn from India and Algiers

In preparing the extract we boiled 50 grams of the chopped hulls with three successive portions of water The three portions were united and then concentrated to about one third of the original bulk The solution was then cooled to below 40 deg C A small amount of egg albumen suspended in water was added the boiling resumed for a few minutes and the solution then filtered hot The addition of the egg albumen was for the purpose of clarifying the solution as otherwise the filtration is exceedingly difficult At first we clarified the solution by addition of Fuller's earth but we find the clarification by egg albumen to be a more satisfactory method We found the yield to be 73 per cent of soluble extractive matter confirming a previous publication of E Walter After the extract has been concentrated to a syrupy consistency it may be treated with fifteen per cent by weight of alcohol the result being a dark liquid essence of high foam producing power The extract so prepared gradually deposits a flocculent precipitate It is advisable after preparing the extract to allow it to stand undisturbed for several weeks until no more precipitate is deposited and then filter it The extract thus finally obtained is a brilliant liquid which does not cause turbidity when added to beverages that are to be carbonated If desired the soap-nut extract may be evaporated to dryness, whereby it is obtained as a light, fawn-colored powder which dissolves easily in water

Through the courtesy of Mr. Hills, president of the Marrowfood Co New York we were put in possession of two pounds of Panama bark We made an extract therefrom in the following manner

Fifty grams of the powdered bark was placed in each of four Erlenmeyer flasks To the first flask was added 250 cubic centimeters of water which was boiled for twenty minutes The extract from this flask was poured into flask No 2 and the boiling repeated Flask No 1 then received 250 cubic centimeters fresh water boiled and the resulting extract transferred to flask No 2 and so on the extract of one flask being transferred to the flask ahead its place being taken by the weaker extract from the flask behind the whole operation partaking somewhat of the nature of diffusion as practiced in beet sugar factories In this way the 200 grams of bark were extracted with the minimum amount of water It is said that some makers of Panama bark extract use 300 gallons of water to get 7 gallons of finished extract which represents a great waste of time and steam in concentrating The yield of dry extract from the bark was 19 5 per cent The yield of the bark is therefore to the yield of the soap nut as 1 is to 3 8 which is quite a difference in favor of the soap nut

We next made some experiments to determine the relative efficiency of the two extracts as foam producers We found that the minimum amount of each required to produce a preceptible foam in distilled water was one part in a hundred thousand To produce a sufficient amount of foam for carbonated beverages however it was necessary to use four parts in a hundred thousand or 0 00025 per cent which is an insignificant quantity

To compare the character of the foam yielded by the two saponine producing materials water was placed in two stoppered cylinders of the same size the same amount of extract added to each then the two flasks were shaken It was found that in comparison with the soap nut extract the Panama bark extract gives a much coarser foam that is one with much larger bubbles The soap-nut foam is in fact very compact and fine grained much more attractive in appearance than the foam produced by the Panama bark extract Moreover although both kinds of foam are very durable the soap nut foam lasts much the longer However this is not a very important point since either will last long enough for all practical purposes

We also made some attempts to determine the relative emulsifying powers of the two extracts when compared with each other and with an equal weight of dry castile soap powder In this test 1 gram of the substance was dissolved in 100 cubic centimeters of distilled water the solution poured into a tall cylinder with a glass stopper 0 2 gram of various powders such as ferric hydroxide and barium sulphate was added the cylinder vigorously shaken and allowed to stand It was noted that the substance settled at practically the same rate in all three cylinders which would indicate that the soap-nut extracts have about the same emulsifying power as soap solution We did not however follow this line of experimentation sufficiently far to warrant definite conclusions

It is interesting to note that the hulls of the soap nut are not the only product of possible value of the soap nut tree The nuts have a hard black seed which is slightly smaller than a hazel nut The shell of the nut is very hard and weighs considerably more than the kernel If ever the soap nut become a commercially important product in Florida the seeds being necessarily a by product they will have more or less value as a source of oil We give below an analysis of the soap nut seed made by us and for comparison the corresponding figures for peanuts to which in respect of its general composition the soap nut seed bears a close resemblance although the flavor and other properties are very different

	Soap Nut Seeds	Peanuts
Moisture	8 40	[illegible]2
Ash	4 04	2 0
Oil	37 18	38 0
Protein	25 38	25 8
Crude Fiber	1 84	[illegible]
Carbohydrates	23 16	24 4

The soap nut seed ash is rich in potash and contains 32 31 per cent phosphoric acid The carbohydrates are chiefly starch pentosans and sucrose No reducing sugar was found Tannin is absent The usual reaction with guiacol and hydrogen peroxide seems to indicate the presence of considerable quantities of peroxidase There is however no saccharifying enzyme present The oil which was obtained by extraction has a bland and very agreeable taste The seed contains one per cent of lecithin

Soap nut hulls of good quality can be bought in Hamburg at 7½ cents a pound which is about the price of Panama bark As however the yield of the soap nut hulls is nearly four times as great as that of the bark the hulls if obtainable in sufficient quantity should have no trouble in driving the bark out of the market

It may be here remarked that many dispensers of carbonated beverages do not use soap nut extract to produce foam —*Pure Products*

Making Money Out of Bees—I*

Keeping Bees for Pleasure and Profit

By E F Phillips, Ph D, in charge of Bee Culture, Bureau of Entomology

INTRODUCTION

Bee keeping for pleasure and profit is carried on by many thousands of people in all parts of the United States As a rule it is not the sole occupation There are however many places where an experienced bee keeper can make a good living by devoting his entire time and attention to this line of work It should be emphasized that it is unwise for the average individual to undertake extensive bee keeping without considerable previous experience on a small scale since there are so many minor details which go to make up success in the work These must be thoroughly understood before there is any hope for continued success It is therefore most desirable to begin on a small scale make the bees pay for themselves and for all additional apparatus as well as some profit and gradually to increase as far as the local conditions or the desires of the individual permit.

Fig 1 —A Well Arranged Apiary

Bee culture is the means of obtaining for human use a natural product which is abundant in almost all parts of the country and which would be lost to us were it not for the honey bee The annual production of honey and wax in the United States makes apiculture a profitable minor industry of the country From its very nature it can never become one of the leading agricultural pursuits but that there is abundant opportunity for its growth can not be doubted

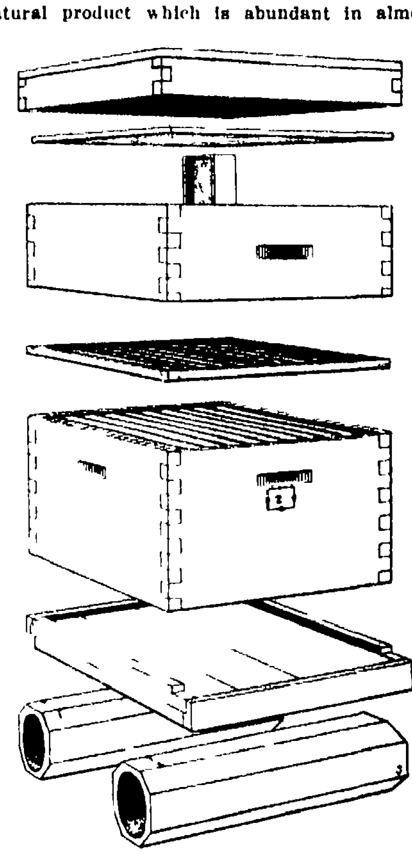


Fig 2 - A Ten frame Hive with Comb honey Super and Perforated Zinc Queen Excluder

Not only is the honey bee valuable as a producer but it is also one of the most beneficial of insects in cross-pollinating the flowers of various economic plants

Bee keeping is also extremely fascinating to the majority of people as a pastime, furnishing outdoor exercise as well as intimacy with an insect whose activity has been a subject of absorbing study from the earliest times It has the advantage of being a recreation which pays its own way and often produces no mean profit

It is a mistake however to paint only the bright side of the picture and leave it to the new bee keeper to discover that there is often another side Where any financial profit is derived bee keeping requires hard work and work at just the proper time otherwise the surplus of honey may be diminished or lost Few lines of work require more study to insure success In years when the available nectar is limited surplus honey is secured only by judicious manipulations and it is only through considerable experience and often by expensive reverses that the bee keeper is able to manipulate properly to save his crop Anyone can produce honey in seasons of plenty but these do not come every year in most locations and it takes a good bee keeper to make the most of poor years When even with the best of manipulations the crop is a failure through lack of nectar the bees must be fed to keep them from starvation

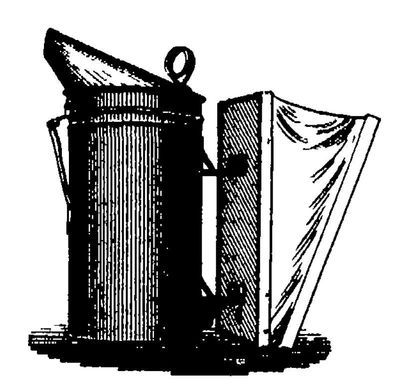


Fig 3 —Smoker

The average annual honey yield per colony for the entire country under good management, will probably be 25 to 30 pounds of comb honey or 40 to 50 pounds of extracted honey The money return to be obtained from the crop depends entirely on the market and the method of selling the honey If sold direct to the consumer extracted honey brings from 10 to 20 cents per pound and comb honey from 15 to 25 cents per section If sold to dealers, the price varies from 6 to 10 cents for extracted honey and from 10 to 15 cents for comb honey All of these estimates depend largely on the quality and neatness of the product. From the gross return must be deducted from 50 cents to $1 per colony for expenses other than labor including foundation sections, occasional new frames and hives and other incidentals not however providing for increase

Above all it should be emphasized that the only way to make bee keeping a profitable business is to produce only a first-class article. We can not control what the bees bring to the hive to any great extent, but by proper manipulations we can get them to produce fancy comb honey or if extracted honey is produced it can be carefully cared for and neatly packed to appeal to the fancy trade Too many bee keepers, in fact the majority, pay too little attention to making their goods attractive They should recognise the fact that of two jars of honey one in an ordinary fruit jar or tin can with a poorly printed label, and the other in a neat glass jar of artistic design with a pleasing attractive label the latter will bring double or more the extra cost of the better package It is perhaps unfortunate but nevertheless a fact, that honey sells largely on appearance and a progressive bee keeper will appeal as strongly as possible to the eye of his customer

Fig 4 —Bee Veil with Silk tulle Front

LOCATION OF THE APIARY

The location of the hives is a matter of considerable importance As a rule it is better for hives to face away from the prevailing wind and to be protected from high winds In the North a south slope is desirable It is advisable for hives to be so placed that the sun will strike them early in the morning so that the bees become active early in the day and thus gain an advantage by getting the first supply of nectar It is also advantageous to have the hives shaded during the hottest part of the day so that the bees will not hang out in front of the hive instead of working They should be so placed that the bees will not prove a nuisance to passers-by or disturb livestock This latter precaution may save the bee keeper considerable trouble for bees sometimes prove dangerous, especially to horses

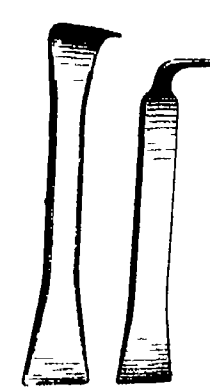


Fig 5 —Hive Tools

The plot on which the hives are placed should be kept free from weeds, especially in front of the entrances. The hives should be far enough apart to permit of free manipulation If hives are too close together there is danger of bees entering the wrong hive on returning especially in the spring

These conditions which may be considered as ideal, need not all be followed When necessary bees may be kept on house tops in the back part of city lots, in the woods, or in many other places where the ideal conditions are not found As a matter of fact, few apiaries are perfectly located, nevertheless, the location should be carefully planned especially when a large number of colonies are kept primarily for profit.

As a rule, it is not considered best to keep more than 100 colonies in one apiary and apiaries should be at least two miles apart. There are so many factors to be considered, however, that no general rule

* Farmer's Bulletin No 397 United States Department of Agriculture

can be laid down The only way to learn how many colonies any given locality will sustain is to study the honey flora and the record of that place until the bee keeper can decide for himself the best number to be kept and where they shall be placed

The experience of a relatively small number of good bee keepers in keeping unusually large apiaries indicates that the capabilities of the average locality are usually underestimated The determination of the size of extensive apiaries is worthy of considerable study for it is obviously desirable to keep bees in as few places as possible to save time in going to

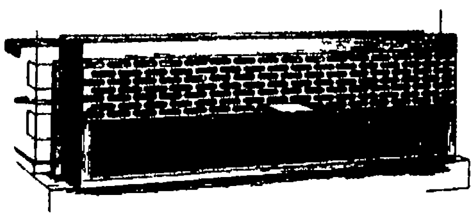


Fig 6 —Drone and Queen Trap on Hive Entrance

them and also expense in duplicated apparatus To the majority of bee keepers this problem is not important for most persons keep but a small number of colonies. This is perhaps a misfortune to the industry as a whole for with fewer apiaries of larger size under the management of careful trained bee keepers the honey production of the country would be marvelously increased For this reason professional bee keepers are not favorably inclined to the making of thousands of amateurs who often spoil a location for a honey producer and more often spoil his market by the injudicious selling of honey for less than it is worth or by putting on the market an inferior article

Out apiaries or those located away from the main apiary should be so located that transportation will be as easy as possibe The primary consideration however must be the available nectar supply and the number of colonies of bees already near enough to draw on the resources The out apiary should also be near to some friendly person so that it may be protected against depredation and so that the owner may be notified if anything goes wrong It is especially desirable to have it in the partial care of some person who can hive swarms or do other similar things that may arise in an emergency The terms under which the apiary is placed on land belonging to some one else is a matter for mutual agreement There is no general usage in this regard

EQUIPMENT IN APPARATUS

It must be insisted that the only profitable way to keep bees is in hives with movable frames The bees build their combs in these frames which can then be manipulated by the bee keeper as necessary The keeping of bees in boxes hollow logs or straw skeps is not profitable is often a menace to progressive bee keepers and should be strongly condemned Bees in box hives (plain boxes with no frames and with combs built at the will of the bees) are too often seen in all parts of the country The owners may obtain from them a few pounds of inferior honey a year and carelessly continue in the antiquated practice In some cases this type of bee keeping does little harm to others but where diseases of the brood are present the box hive is a serious nuisance and should be abolished

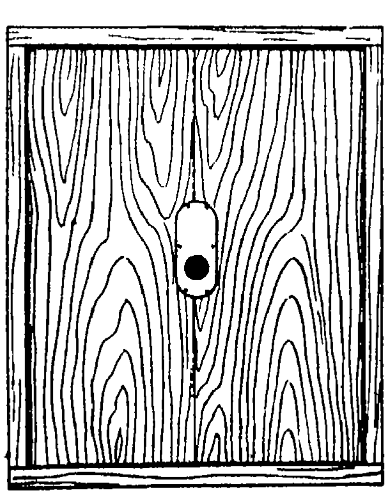


Fig 7 —Bee Escape for Removing Bees from Supers

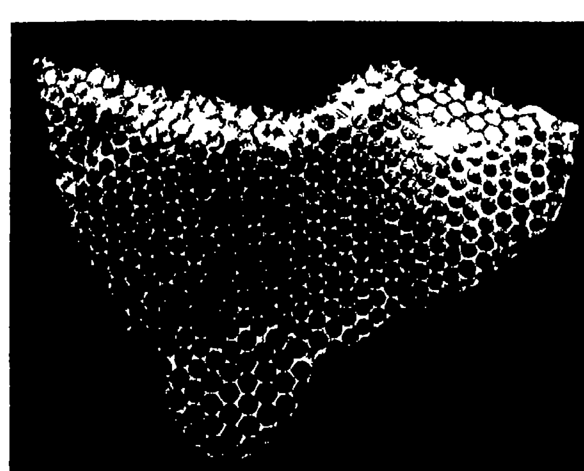


Fig 10 —Piece of Comb Showing Worker and Dr r Cells with Irregular Transit ons Red iced

HIVES.

It is not the purpose of this bulletin to advocate the use of any particular make of hive or other apparatus Some general statements may be made however, which may help the beginner in his choice

The type of hive most generally used in this country Fig. 2) was invented by Langstroth in 1851 It consists of a plain wooden box holding frames hung from [illegible] at the top and not touching the sides, top, [illegible] Hives of this type are made to hold from eight frames upward The size of frame in general use, known as the Langstroth (or L) frame (9⅛ by 17⅝ inches) is more widely used than all others combined The number of frames used depends on the kind of honey produced (whether comb or extracted) and on the length of honey flow and other local factors There are other hives used which have points of superiority These will be found discussed in the various books on bee keeping and in the catalogues of dealers in bee keepers supplies

Whatever hive is chosen there are certain points of importance which should be insisted on The material should be of the best the parts must be accurately made so that all frames or hives in the apiary are interchangeable All hives should be of the same style and size they should be as simple as it is possible to make them to facilitate operation Simple frames diminish the amount of propolis, whi h will interfere with manipulation As a rule it is better to buy hives and frames from a manufacturer of such goods rather than to try to make them unless one is a good wood worker

The choice of a hive while important, is usually given undue prominence in books on bees In actual practice experienced bee keepers with different sizes and makes of hives under similar conditions do not find as much difference in their honey crop as one would be led to believe from the various published accounts

HIVE STANDS

Generally it is best to have each hive on a separate stand The entrance should be lower than any other part of the hive Stands of wood bricks tile (Fig 2) concrete blocks or any other convenient material will answer the purpose The hive should be raised above the ground so that the bottom will not rot It

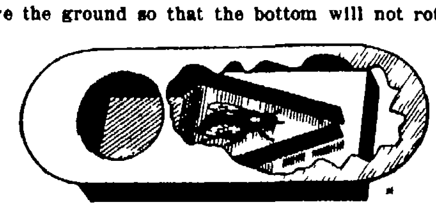


Fig 8 S[illegible] Bee Es[illegible]pe

is usually not necessary to raise the hive more than a few inches Where ants are a nuisance special hive stands are sometimes necessary

OTHER APPARATUS

In addition to the hives in which the bees are kept some other apparatus is necessary A good smoker (Fig 3) consisting of a tin or copper receptacle to hold burning rotten wood or other material with a bellows attached is indispensable A veil of black material preferably with a silk t ille front (Fig 4) should be used Wire-cloth veils are also excellent Even if a veil is not always used it is desirable to have one at hand in case the bees becom cross Cloth or leather gloves are sometimes used to protect the hands but they hinder most manipulations Some sort of tool (Fig 5) to pry hive covers loose and frames apart is desirable A screw driver will answer but any of the tools especially for that purpose is perhaps better Division boards drone traps (Fig 6) bee escapes (Figs 7 and 8) feeders (Figs 14 15 16 17) foundation fasteners wax extractors bee brushes (Fig. 9) queen rearing outfits and apparatus for producing comb or extracted honey (Figs 2 18 19) will be found described in catalogues of supplies a full discussion of these implements would require too much space in this bulletin A few of these things are illustrated and their use will be evident to the bee keeper It should be remembered that manipulation based on a knowledge of bee activity is of far greater importance than any particular style of apparatus, and in a short discussion like the present it should be given more space especially since supply dealers will be glad to furnish whatever information is desired concerning apparatus

EQUIPMENT IN BEES

As stated previously it is desirable to begin bee keeping with a small number of colonies In purchasing these it is usually best to obtain them near at home rather than to send to a distance for there is considerable liability of loss in shipment. Whenever possible it will be better to get bees already domiciled in the particular hive chosen by the bee keeper as the best but if this is not practicable then bees in any hives or in box hives may be purchased and transferred It is a matter of small importance

Fig 9 Bee Brush

what race of bees is purchased for queens of any race may be obtained and introduced in place of the original queen and in a short time the workers will all be of the same race as the introduced queen This is due to the fact that during the season worker bees die rapidly and after requeening they are replaced by the offspring of the new queen

A most important consideration in purchasing colonies of bees is to see to it that they are free from disease In many States and counties there are inspectors of apiari s wl o an l e ns l l o this point but if this is not possible even a novice can tell whether or not there is anything wrong with the brood and it is always safest to refuse hives containing dead brood

The best time of the year to begin bee keeping is in the spring for during the first few months of ownership the bee keeper can study the subject and learn what to do so that he is not so likely to make a mistake which will end in loss of bees It is usually best to buy good strong colonies with plenty of brood for that season of the year but if this is not practicable then smaller colonies or nuclei may be purchased and built up during the season Of course no surplus honey can be expected if all the honey gathered goes into the making of additional bees It is desirable to get as little drone comb as possible and a good supply of honey in the colonies purchased

The question as to what race and strain of bees is to be kept is important If poor stock has been purchased locally the bee keeper should send to some reliable queen breeder for good queens as a foundation for his apiary Queens may be purchased for $1 each for untested to several dollars each for select ed breeding queens Usually it will not pay beginners to buy selected breeding queens for they are not yet prepared to make the best use of such stock Untested or tested queens are usually as good a quality as are profitable for a year or so and there is also less danger in mailing untested (young) queens

Various races of bees have been imported into the United States and among experienced bee keepers there are ardent advocates of almost all of them The black or German race was the first imported very early in the history of the country and is found every where but usually not entirely pure As a rule this race is not desirable No attention has been paid to breeding it for improvement in this country and it is usually found in the hands of careless bee keepers As a result it is inferior although it often produces beautiful comb honey

The Italian bees the next introduced are the most popular race among the best bee keepers in this country and with good reason They are vigorous work

ers and good honey gatherers defend their hives well and above all have been more carefully selected by American breeders than any other race Especially for the last reason it is usually desirable to keep this race That almost any other race of bees known could be bred to as high a point as the Italians and perhaps higher can not be doubted but the bee keeper now gets the benefit of what has been done for this race It should not be understood from this that the efforts at breeding have been highly successful On the contrary bee breeding will compare very unfavorably with the improvement of other animals or plants which have been the subject of breeding investigations

Italian bees have been carefully selected for color by some breeders to increase the area of yellow on the abdomen until we now have what are known as five banded bees These are very beautiful but it can scarcely be claimed that they are improved as honey producers or in regard to gentleness They are kept mostly by amateurs

Some breeders have claimed to select Italians for greater length of tongue with the object of getting a bee which could obtain the abundance of nectar from red clover If any gain is ever made in this respect it is soon lost The terms red clover bees or long tongued bees are somewhat misleading but are ordinarily used as indicating good honey producers

Caucasian bees recently distributed throughout the country by this Department are the most gentle race of bees known They are not stingless however as is often stated in newspapers and other periodicals Many report them as good honey gatherers They are more prolific than Italians and may possibly become popular Their worst characteristic is that they gather great quantities of propolis and build burr and brace combs very freely They are most desirable bees for the amateur or for experimental purposes

Carniolan and Banat bees have some advocates and are desirable in that they are gentle Little is known of Banats in this country Carniolans swarm excessively unless in large hives Cyprians were formerly used somewhat but are now rarely found pure and are undesirable either pure or in crosses because of the fact that they sting with the least provocation and are not manageable with smoke They are good honey gatherers but their undesirable qualities have caused them to be discarded by American bee keepers Holy land Egyptian and Tunic (Tunisian) bees have also been tried and have been universally abandoned

BEE BEHAVIOR

The successful manipulation of bees depends entirely on a knowledge of their habits This is not generally recognized and most of the literature on practical bee keeping consists of sets of rules to guide manipulations This is too true of the present paper but is due to a desire to make the bulletin short and concise While this method usually answers it is nevertheless faulty in that without a knowledge of fundamental principles of behavior the bee keeper is unable to recognize the seemingly abnormal phases of activity and does not know what to do under such circumstances Rules must of course be based on the usual behavior By years of association the bee keeper almost unconsciously acquires a wide knowledge of bee behavior and consequently is better able to solve the problems which constantly arise However it would save an infinite number of mistakes and would add greatly to the interest of the work if more time were expended on a study of behavior then the knowledge gained can be applied to practical manipulation

A colony of bees consists normally of one queen bee the mother of the colony and thousands of sexually undeveloped females called workers which normally lay no eggs but gather the stores keep the hive clean feed the young and do the other work of the hive During part of the year there are also present some hundreds of males or drones (often removed or restricted in numbers by the bee keeper) whose only service is to mate with young queens These three types are easily recognized even by a novice In nature the colony lives in a hollow tree or other cavity, but under manipulation thrives in the artificial hives provided The combs which form their abode are composed of wax secreted by the workers The hexagonal cells of the two vertical layers constituting each comb have interplaced ends on a common septum In the cells of these combs are reared the developing bees and here are stored honey and pollen for food

The cells built naturally are not all of the same size those used in rearing worker bees being about one fifth of an inch across and those used in rearing drones and in storing honey about one fourth of an inch across (Fig 10) The storage cells are more irregular and generally curve upward at the outer end Under manipulation the size of the cells is controlled by the bee keeper by the use of comb foundation—sheets of pure beeswax on which are impressed the bases of cells and on which the bees build the side walls

In the North when the activity of the spring begins the normal colony consists of the queen and some thousands of workers As the workers bring in early pollen honey the queen begins to lay eggs in the worker cells These in time develop into white larvæ which grow to fill the cells They are then capped over and transform gradually into adult worker bees As the weather grows warmer and the colony increases in size by the emergence of the developing bees the quantity of brood is increased The workers continue to bring in pollen and nectar to be made into honey After a time the queen begins to lay eggs in the larger cells and these develop into drones or males

Continued increase of the colony would result in the formation of enormous colonies and unless some division takes place no increase in the number of colonies will result Finally however the workers begin to build queen cells over certain female larvæ These are larger than any other cells in the hive and hang on the comb vertically In size and shape they may be likened to a peanut and are also rough on the outside When the larvæ in these cells have grown to full size they are sealed up and the colony is then ready for swarming

Swarming consists of the exit from the hive of the original queen with part of the workers They leave the hive to seek a new home and begin the building of combs storing of honey and pollen and rearing of brood in a new location They leave behind the honey stores except such as they can carry in their honey stomachs and the brood some workers and no adult queen but several queen cells from which will later emerge young queens By this interesting process the original colony is divided into two

The swarm finds a new location either in a hollow tree or if cared for by the bee keeper in a hive The workers build new combs the queen begins laying and in a short time the colony is again in normal condition

The colony on the old stand (parent colony) has the advantage of the bees which emerge from the brood After a time (usually about nine days) the queens in their cells are ready to emerge. If the colony is only moderately strong the first queen to emerge is allowed by the workers to tear down the other queen cells and kill the queens not yet emerged but if a second swarm is to be given off the queen cells are protected

If the weather permits after from five to eight days the young queen flies from the hive to mate with a drone Mating usually occurs but once during the life of the queen and always takes place on the wing In this single mating she receives enough spermatozoa to last throughout her life She returns to the hive after mating and in about two days begins egg laying The queen never leaves the hive except at mating time or with a swarm and her sole duty in the colony is to lay eggs to keep up the population

When the flowers are in bloom which furnish most nectar the bees usually gather more honey than they need for their own use, and this the bee keeper can safely remove They continue the collection of honey and other activities until cold weather comes on in the fall when brood rearing ceases, they then become relatively quiet remaining in the hive all winter except for short flights on warm days When the main honey flow is over the drones are usually driven from the hive By that time the virgin queens have been mated and drones are of no further use They are not usually stung to death but are merely carried or driven from the hive by the workers and starve A colony of bees which for any reason is without a queen does not expel the drones

Many abnormal conditions may arise in the activity of a colony and it is therefore necessary for the bee keeper to understand most of these so that when they occur he may overcome them If a virgin queen is prevented from mating she generally dies but occasionally begins to lay eggs after about four weeks In this event however all of the eggs which develop become males Such a queen is commonly called a drone-layer

If the virgin queen is lost while on her flight or the colony at any other time is left queenless without means of rearing additional queens it sometimes happens that some of the workers begin to lay eggs These eggs also develop only into drones

It also happens at times that when a queen becomes old her supply of spermatozoa is exhausted at which time her eggs also develop only into drones These facts are the basis of the theory that the drone of the bee is developed from an unfertilized egg or is parthenogenetic A full discussion of this point is impossible at this time

The work of the hive is very nicely apportioned among the inmates so that there is little lost effort As has been stated the rearing of young is accomplished by having one individual to lay eggs and numerous other (immature females) to care for the larvæ In like manner all work of the colony is apportioned In general it may be stated that all inside work—wax building care of brood and cleaning—is done by the younger workers those less than seventeen days old while the outside work of collecting pollen and nectar to be made into honey is done by the older workers This plan may be changed by special conditions For example if the colony has been queenless for a time and a queen is then given old workers may begin the inside work of feeding larvæ and these may also secrete wax Or if the old workers are all removed the younger bees may begin outside work As a rule however the general plan of division of labor according to age is followed rather closely

(To be continued)

Physical Anomalies of Water

WATER is a paradoxical and unique substance A thermometer filled with water instead of mercury or alcohol gives reliable indications of moderate temperatures but when it is cooled below 4 deg C (about 39 deg F) it ceases to fall and begins to rise and at the freezing point (0 deg C or 32 deg F) it stands at the same height as at 8 deg C (about 46½ deg F) In other words water attains its maximum density at 4 deg C and when it is cooled below this point it expands instead of contracting In the act of freezing another and a sudden expansion takes place which is the opposite of what occurs in the solidification of most substances Hence ice floats on water a fact of immense geological and biological importance which prevents lakes and streams from freezing solid and preserves the animal and vegetable organisms which they contain In all latitudes and at all seasons the temperature at great depths in the ocean is approximately 4 deg C

The compressibility viscosity and specific heat of water exhibit corresponding anomalies all of which have been attributed by Roentgen to a common cause Roentgen assumed that water even at ordinary temperatures contains a variable number of polymonized or agglutinated molecules probably identical with the molecules of ice or that water may be regarded as a solution of ice as syrup is a solution of sugar The number of these complex molecules diminishes as the temperature rises

This view is supported by the measurements of Ramsay and Shields who account for the peculiar properties of water by the presence of associated molecules

A note in *Cosmos* states that Duclaux from his recent study of this theory concludes in agreement with Sutherland that the molecule of ice is probably found by the combination of three molecules of water or that the molecular weight of ice is 54 and its chemical formula is $(H_2O)_3$

Destruction of Concrete by Hydrogen Sulphide

THE rapid disintegration of the concrete walls of sewage basins has often been observed The German journal *Beton und Eisen* give an account of Stephan's investigation of the deterioration observed in the concrete vaulted roof of a sewage sedmentation basin As the crude sewage smelled strongly of hydrogen sulphide while none of this gas was found either in the clarified sewage or in the air beneath the vault, Stephan concluded that the hydrogen sulphide disengaged by the sewage was entirely absorbed by the concrete and was the cause of the observed corrosion.

Hydrogen sulphide can destroy concrete by combining with its lime to form calcium sulphide which may then be converted into soluble calcium bisulphide or oxidized to soluble calcium sulphate The analysis of specimens of the concrete of the vault confirmed these conclusions but showed, also that part of the drainage was due to the presence of carbon dioxide and the consequent formation of soluble calcium bicarbonate

Stephan suggests a very simple method of preventing corrosion by coating with tar after the concrete has hardened all parts of the wall that are exposed to the contact of injurious gases

The Railophone

THE various systems which have been devised for telephoning to and from moving railway trains have, as a rule proved unsatisfactory A new system, invented by Von Kramer and bearing the queer name railophone," has been employed with success on the line connecting London with Brighton A large coil of wire is placed on the roof of the car with its plane vertical and parallel to the rails, and its ends are connected to a telephone receiver installed in a sound proof cabinet inside the car This coil is inductively affected by a fixed circuit composed of an overhead telegraph wire and a cable buried beside the rail, and connected with a telephone transmitter at a station A circuit of this kind is provided for each track.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending February 7, 1911,

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Acoustic diaphragm W W Young 983 410
Adding machine resetting device J A Cheape 983 682
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Aeroplane Harrell & Dalley 983 707
Air brakes, bleed cock for J M Dooley 983 610
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Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co. Inc., 361 Broadway, New York.

How Sea Water Freezes

Arctowski has made a series of interesting observations of the congelation of sea water. By lying down beside a hole cut in the ice formed on sea water he was enabled to view at short range the formation of new ice close to the wall of ice surrounding the hole. At the surface of the water thin hexagonal plates of ice gradually developed in delicate fern like forms and grew by attracting to themselves minute crystals which formed spontaneously in the moving water. The formation of these crystals increased the density of portions of the water so that the liquid filaments of different densities were made visible by refraction as in a non homogeneous mixture of alcohol and water. The floating hexagonal plates attained diameters ranging from ⅓ inch to 1½ inches and grouped themselves together irregularly leaving interstices usually of triangular form.

At a depth of 6 or 8 inches below the surface of the water leaf like forms from 4 to 10 inches long and with serrated edges subsequently grew from the ice surrounding the hole. The planes of these leaves were usually vertical and their axes horizontal.

The quantity of salt in sea water ice is variable. One specimen contained 2 parts in 10 000 while the water in the vicinity contained 323 parts in 10 000. Another specimen showed 114 parts in 10 000 but when some of the same ice was partially melted very slowly the remaining portion was found to contain only 16 parts of salt in 10 000.

State Report on Oil and Gas Development in Tennessee

By George H Ashley State Geologist

The State Geological Survey has just gotten out a report on the development of the oil and gas industry in Tennessee. The report which is short and preliminary in nature is by Mr M J Munn oil and gas expert of the United States Geological Survey and describes the result of work done by him last summer in co operation with the State Survey. It describes the early finding of oil and gas in Overton and Fentress counties the striking of gushers there the decline of fields and the abandonment of many of them. Then the counties of middle and west Tennessee are taken up in order, and the developments of each described. The report does not go at length into the geology of the oil and gas deposits of the State that being left to a fuller report which it is planned to prepare within the next one or two years.

In the final chapter Mr Munn discusses the future possibilities of Tennessee as an oil and gas State. Long experience has indicated that the Great Valley of Tennessee lying east of the Cumberlands is not an oil and gas territory as drilling from Pennsylvania to Alabama in that belt has universally resulted in commercial failures. He also condemns the rocks of the middle basin of Tennessee as probably non-oil producing based simply upon the fact that the rocks occurring in the center of that basin are lower stratigraphically than any rocks that have yet produced oil in commercial quantities. While this is only negative evidence yet in view of the large number of wells which have been drilled in rocks of that age so far without result, the evidence is not encouraging. The Cumberland Plateau Mr Munn considers much more hopeful and especially the western edge and possibly also the Highland Rim region between the central basin and the Cumberlands. The Highland Rim region in the western part of middle Tennessee is also considered to be possibly an oil and gas territory.

In west Tennessee no commercial oil or gas has yet been obtained but the conditions are considered as hopeful especially along the crest of the divide between the Tennessee-Mississippi rivers.

In general Mr Munn finds that Tennessee is producing no oil and gas to-day in commercial quantities beyond a few wells that hardly pay interest on their investments. In a few cases gas wells are supplying one or two houses with gas or form the source of gas being burned in flambeau. Of the large number of wells drilled in this State the great majority have been "dry holes" or unproductive. Nearly all of these holes however report shows of oil or gas suggesting that there may be a large quantity of those substances in the rocks. A study of the situation suggests that the difficulty is the lack of porous rock or rocks that may serve as reservoirs. In practically all of the oil fields, the oil and gas is found in porous sandstones and limestones the pores being large enough to allow the ready flow of oil or gas. This being of course only one of the conditions under which a flow is obtained and as far as can be ascertained over much of this State, rocks of that character so situated as to hold oil or gas are lacking. In the case of the past oil and gas production in the Cumberlands most of it appears to have come from crevices in a limestone near the surface.

In an appendix the State Geologist discusses results of recent drilling in West Tennessee. He compares the conditions there with those in Louisiana and Texas, where oil and gas have been found, and concludes that while no oil and gas have been found in West Tennessee, and while the peculiar salt dome conditions existing in Louisiana and Texas which have produced most of the gushers of those States, probably do not exist in Tennessee, yet that it is possible or probable that some oil and gas may be found there but that it may require the drilling of nine or ninety nine "dry wells" before one producing well is found. that the search for oil and gas in West Tennessee at the present stage of the game is only a gamble, in which no one should play who cannot afford to lose and lose heavily without feeling it, in the prospect of ultimately striking oil and recovering all that they have expended and then some.

The students of the School of Engineering at the Pennsylvania State College are erecting a wireless telegraph station designed for communication with the stations at Washington, New York, Philadelphia, Boston and elsewhere. Among the uses which will be made of the apparatus reporting football matches played by the college team in other cities where suitable wireless telegraphic equipments have been erected may be mentioned. A level circular track, 200 feet in diameter for making tests upon aeroplanes and propellers has also been erected. A car driven by an electric motor will run upon this track at speeds up to 60 miles per hour. To this car will be attached the planes or propellers to be tested. The frictional resistance or lifting power of the planes and the propelling force and efficiency of propellers will be determined by a series of dynamometers, recording the results obtained by electrical means on instruments placed upon a platform at the center of the circular track. The problem of plane shape and surface can be readily studied by this apparatus as can also data relating to the shape size and speed of the propellers.

Important AND Instructive Articles on AVIATION

In the Scientific American Supplement we have published in the past few years papers by some of the more eminent physicists and engineers on flying machines. No book thus far published is so complete and so authoritative as these articles. The range of the articles is wide, covering as it does the theoretical side of aviation as well as those more practical aspects which deal with the construction of machines. The following is a partial list of the more important articles which have appeared in the Scientific American Supplement, see special note below.

Nos. 1816 1817 1818 1819 1820, 1821 and 1822 THE PRACTICE AND THEORY OF AVIATION
By Grover Cleveland Loening, A. M.

This is the most compact paper on aeroplanes that has probably ever been published. Fourteen biplanes and monoplanes are described in detail and illustrated with scale drawings namely the Farman, Cody, Curtiss, Wright Voisin (old model) Voisin (new model), and Summer biplanes, and the Antoinette, Santos Dumont, Bleriot XI, Bleriot XII, Grade, Pfitzner monoplanes. The proper dimensioning of aeroplane surfaces as deduced by famous experimenters from their tests is also considered. Taken as a whole, this series of seven papers constitutes an admirable text book.

No. 1713 THE WRIGHT AEROPLANE

This is a thorough description of the old type of Wright biplane with the horizontal elevation rudder in the front of the machine. Excellent diagrams and photographic views accompany the paper.

No. 1756. LOIS BLERIOT AND HIS AEROPLANES

Few people realize that Bleriot's successful monoplane is the result of ten years of daring and perilous experiment. In this paper will be found an instructive description of the evolution of the present successful Bleriot monoplane, illustrated with diagrams and photographs.

No. 1788. THE FARMAN BIPLANE

A complete description of the Farman biplane, with detail drawings of the box tail and vertical rudders, the manner of working the four ailerons, hand and foot levers which control the machine, plan view and side elevation of the entire machine.

No. 1767 THE SANTOS-DUMONT MONOPLANE

An illustrated article describing the Demoiselle, the smallest and one of the fastest machines thus far made. Sketches accompany the article, showing the details of the construction and control.

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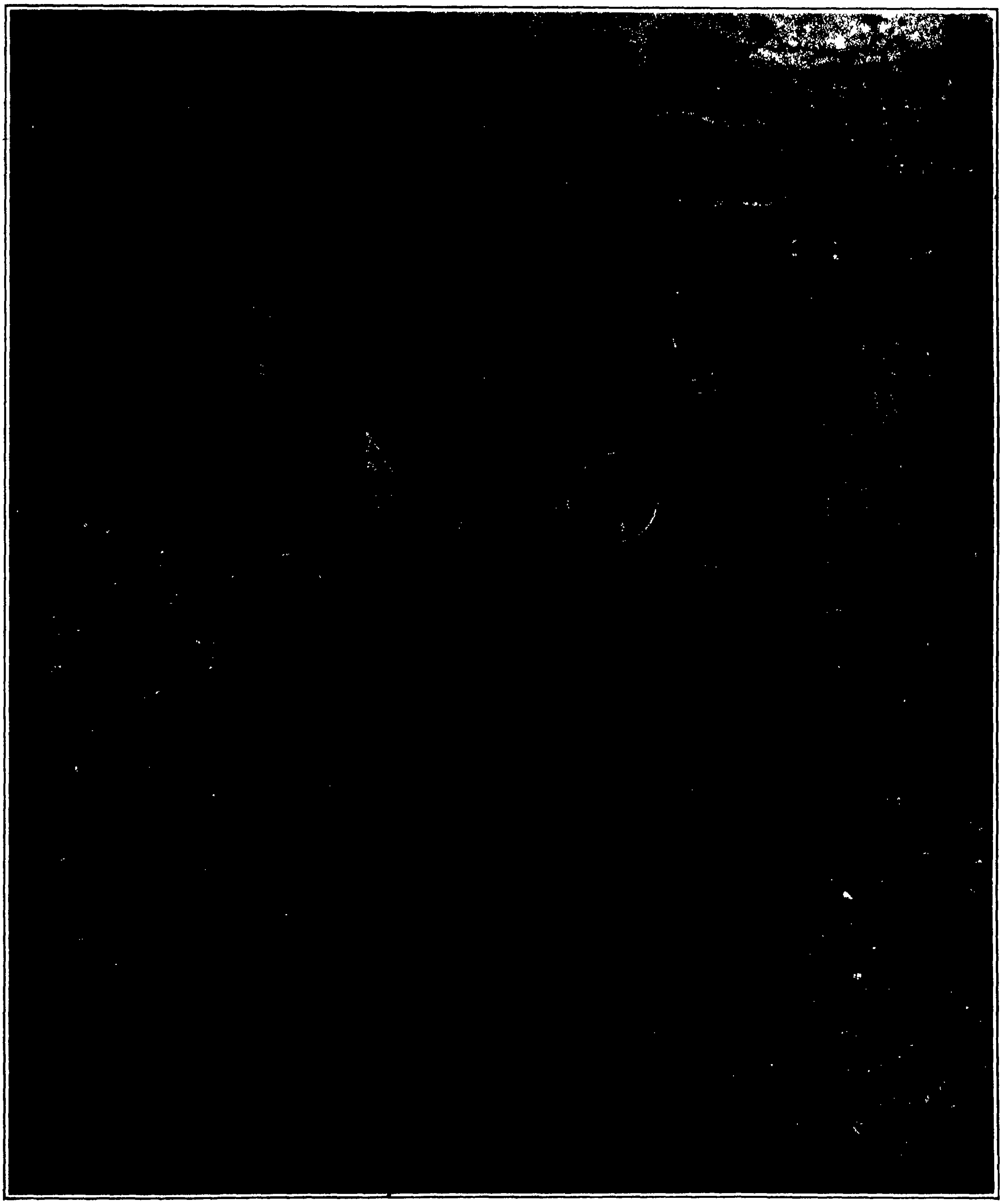


FIG 1—TEN-TON ELECTRIC LOCOMOTIVE IN A COAL MINE

MODERN COAL-CUTTING MACHINERY AND MINE RAILWAYS —[See page 120]

Production of Low Temperature and Refrigeration—II*

The First International Congress of Refrigerative Industries

By L. Marchis

Concluded from Supplement No 1833, page 103

COLD STORAGE ROOMS are cooled by different methods. In the first place one of the most common methods is to direct dry cold air into the preserving rooms. This air is brought down to a low temperature and sufficiently dried out either by passing over a cold saline solution (spray refrigerator) or by circulation in contact with a coil acting as refrigerant (dry refrigerator). The choice of the type of refrigerator as M Barrier has said is a question of circumstances. Even in the case of meat preservation it makes a difference whether the meat is frozen, that is to say immunized, or whether it is merely refrigerated (brought to a temperature between zero and 4 deg C) where it is more particularly subject to the action of harmful germs. It also makes a difference whether it is a military storehouse where the meat is only taken out for immediate consumption and the refrigerating chambers are closed up to the time the food is removed or whether it is a commercial storehouse where the meat is taken in or brought out daily and is more or less exposed to the air and where the frequent entries of the workmen carry in noxious gases and impurities. In this latter case the spray evaporator appears preferable on account of the purification and asepsis of the air of the chambers. In the first case however the dry evaporator on account of its greater simplicity and the lowering of the concentration of the brine presents some real advantages.

It is not sufficient only to produce cold; the cold must be conserved. For this reason the insulation from heat should be considered a question of the first importance in the construction of a cold store. The proper conservation of the contents demands that the temperature of the storage chambers should be as constant as possible. The question of insulating materials therefore has been a subject of particular attention by the congress.

A good heat insulator should fulfill the following conditions:

(1) It should be a very poor conductor of heat. If a very thin layer of the insulator is sufficient to obtain proper insulation the result is both economy of space and economy of the insulating material.

(2) It should have a low specific gravity. This condition is important in insulation installment aboard ship. Its importance is not less however in cold storage warehouses because of the reduction of cost in transporting it to the work and the possibility of economy in the cost of construction by making possible the construction of very lightly built buildings.

(3) The insulator should be free from odor and not subject to decomposition even when moist. This condition is all important in the construction of cold storage houses designed for the preservation of food stuffs. These absorb very easily bad odors arising from the fermentation of insulating material and become unfit for consumption. For this reason such substances as rice husks, cut straw, oat husks or cork mixtures made with fermentable substances such as casein, should be rejected.

(4) The insulating material should absorb to as great a degree as possible the bad odors which are set free in refrigerating chambers and render them less harmful. From this point of view peat or turf some times is of great service.

(5) The insulating material should not be hygroscopic. It should not absorb and retain moisture which is capable of causing it to lose its poor conducting qualities. This is the case with mineral wool, a sort of fibrous glass made out of the slag of blast furnaces.

(6) When by reason of circumstances such as the breaking of a water tube etc an insulating material is wet it should be able to dry out easily and regain its property of poor conduction.

(7) The insulating substances should not be attractive to parasites, mice, rats etc nor afford a good culture ground for microbes.

(8) The insulation material should be incombustible or at least should not propagate combustion started at any point of the mass. A certain number of cork mixtures possess this property, for example the mixture of cork and pitch. M Brüll has shown to the congress several different types of entirely fire-proof cork mixtures.

(9) When once placed in the packing which makes up the insulating mat either inside or outside of the wall the insulating material should not settle and thus produce continuous voids in the insulation. The different wood carbons included under the term charcoal are liable to this disadvantage when they are used without special precautions.

(10) The insulating materials should not attack the wood, iron or masonry which comes in contact with them.

(11) The insulating materials should be very easy to work and to apply to the walls of the storage chambers and should possess a certain resistance to bending or crushing.

(12) The insulation should not lose its qualities with time.

It is difficult enough to find an insulation that combines all these qualities. Cork either in granular form or agglomerated however is at present the most employed. M Pasquay has informed the congress that silk waste protected by an impermeable envelope forms an excellent insulation.

The knowledge of the co-efficient of conduction of insulators is of great importance with regard to the thickness which the protecting linings must be to bring down the loss of cold within a certain limit. Different methods have been proposed for determining this. In one of these the two faces of a plate of the substance are maintained constantly at different temperatures and the quantity of heat passing through the plate in a certain time determined. This may be accurately measured by weighing the amount of ice melted. This is the principle of the well known physical method called the wall method. It may perhaps be remarked that those who have used this method have not taken precautions against the loss of heat at the edges of the experimental plates. They have not made use of the method of using a guard ring in the form originated by M Berget.

The other methods for measuring the conductibility are based on Forbes method. This consists of heating one of the extremities of a long slender bar of the material to be tested. When the system has attained an equilibrium the temperature is taken at different points along the bar and by the formulæ of Fourrier the coefficient of conductibility can be calculated if that of emission is known. This latter may be that of a coating or a very thin layer of metal with which the bar has been previously provided.

A variation of the Forbes method is that of the sectional bar of Lodge. This bar is composed of three sections, the first and the third are of a metal the conductibility of which is known. The second is made up of the material to be tested. The end of the first section is heated and the progression of temperature when equilibrium is established is measured. The general formula for uniform movement of heat in an elongated bar makes possible the calculation of the conductibility of the material composing the second section.

It is this method that M Desvignes has used in determining the conductibility of several insulating substances. He has worked out the technique so that it can be easily employed in the refrigerating industry.

Some of the results obtained by this method are as follows:

Coefficient of Conductibility

	Calories for Meter-Degree Hour
Cork	0 05 to 0 014
Granular cork	068
Cork with casein binder	069
Cork with odorless pitch binder	087
Cork with sodium silicate binder	067
Cork mixed with infusorial earth and calcined	069

As M Desvignes has remarked it would perhaps be imprudent to take these figures as a basis for the calculation of loss in a cold-storage plant. The specimens which were used in the tests were picked and were perfectly dry. The given coefficients should be increased not less than 20 per cent. In the application to certain materials some account should be taken of the method of joining. Thus in a partition of cork bricks pointed by cement mortar where the joints represent in very careful work about 15 per cent of the total volume the coefficient of conductibility of the brick itself, referred to the total surface of the partition should be almost doubled. These considerations will show what a difficult question even the approximate calculation of the heating effect due to the walls of the refrigerator may be. The second section has withheld opinion on this question therefore and adopted the following resolutions:

(1) That study and research shall be undertaken in the technical schools and laboratories to determine either by known apparatus or that which shall be subsequently devised the specific constants of the different insulators which are practically utilizable in the refrigerating industry.

(2) That the characteristic properties and constants to be determined by account being taken in each case of the degree of humidity in the following:

The density to be employed.
The coefficient of conductibility.
The resistance to flexure.
The resistance to crushing.
The power of expelling water.
The power of absorbing odors.
The incombustibility.

These constants should be determined under conditions of temperature and thickness of material applicable to the refrigerating industry.

(3) That the second section shall call especial attention to the study of the conductibility as a function of temperature, thickness, degree of humidity and of other causes capable of influencing the conductibility, for example the state of division of the material necessary to assure a certain insulation.

(4) That the section requests that the International Bureau of the Refrigeration Congresses, the organization of which has been planned, shall constitute an international commission charged with taking up the study of methods of testing and co-ordinating with a view to establishing methods and obtaining comparable results any researches which are made in which otherwise the investigators would have their usual latitude.

(5) That it shall be of interest to submit the question of securing uniformity of such methods to the next congress if the researches concerned are sufficiently advanced.

Official instruction up to the present time has been somewhat neglectful of the refrigerating industry. The present-day developments of this industry render more and more necessary the education of engineers who are specialists in this line. For this reason the second section has also enacted the following resolutions:

(1) That theoretical and professional instruction applied to different present-day phases of the industry of refrigeration and with a view to new applications shall be inaugurated in the laboratories and higher technical schools of all countries, this course of instruction to be followed by detailed practical study of important refrigerating establishments and rational experimentation with the machinery there used under the direction of specialists.

(2) That in order that the necessary scientific equipment and experimental material and the cost of the experiments may be provided for this instruction should be subsidized by the governments, municipalities, chambers of commerce, industrial societies, agricultural syndicates and all other individually or collectively interested in the refrigeration industry.

(3) That the general work and the results of researches carried out in these laboratories and schools as well as those of associations of engineers and manufacturers who are working in refrigeration should be submitted to the permanent International Bureau and co-ordinated by it in order that it may publish periodically a bibliographical index and may compare the results and derive all the useful indications and conclusions possible from them for presentation to the next Congress of Refrigeration for its examination.

III THE CONSERVATION OF PERISHABLE ARTICLES

We have now found out how to produce and maintain a low temperature in cold stores. It remains now to study the methods of construction and use of the cold storage rooms, and the rules permitting of the conservation of different sorts of articles. These questions have been the subject of numerous reports and discussions which it would take too much time to digest here. I will, therefore, only indicate some of the most important conclusions on these questions.

The cold air of rooms in a cold storage house should circulate as little as possible from one chamber to another, in order that the odors of certain preserved products may not affect others. In particular, if the refrigeration of the cold store is accomplished

*Translated for the Smithsonian Institution's Annual Report from the Revue générale des Sciences pures et appliquées, Paris, twentieth year, No 5, March 15th 1909.

by means of air coolers it is absolutely necessary to have a special air cooler for each series of chambers designed to contain a particular product.

The articles to be preserved should not pass suddenly from the ordinary temperature to the temperature of the storage rooms, or vice versa, in other words, the refrigeration should be progressive. Thus in abattoirs the warm meat coming from the slaughter rooms is transported by means of an overhead rail into a cold anteroom kept at a temperature of 7 deg to 8 deg C There it undergoes for about twenty four hours a preliminary cooling at the termination of which it is carried into the rooms where the air is maintained at a temperature of 0 deg to 4 deg C and a humidity lower than 75 per cent Salting and treatment of the intestines the hides etc should be carried on in rooms entirely separate from the fore going which should be confined solely to the preservation of fresh meat

The question of the preservation of horticultural products is one of the most difficult in the application of cold to food stuffs The preservation of apples and pears has been studied in detail in the United States by Mr G H Powell He has placed results be fore the congress which demonstrate with the greatest clearness the effect of placing in the refrigerating chamber freshly picked fruits in comparison with those that have been exposed to the air several days after picking It is necessary to place the sound fruit in the cold fruit chamber soon after it is gath ered Other circumstances also influence its keeping qualities It is much better if the fruit comes from older trees It also appears that sandy soils are not favorable to preservation

Fruits with a thick skin keep much better than those with an easily ruptured covering The peach in particular is one of the most difficult of fruits to preserve M Loiseau horticulturalist at Montreuil however has succeeded in keeping this delicate fruit more than a month According to him it is especi ally necessary to maintain the temperature as con stant as possible varying not more than from 0 deg to 1 deg C

Among the recent applications of low temperatures which have been pointed out may be mentioned the use of artificial cold in the manufacture of paraffin and viscose

Crude petroleum generally contains from 5 to 6 per cent of paraffin in solution To obtain this paraf fin the petroleum is distilled until it contains from 10 to 25 per cent of paraffin Then by lowering the temperature of this liquid (paraffin oil) to a degree which varies according to the quality from +16 deg to —18 deg C paraffin is obtained which separates from the oil in the form of crystals which can be separated from the oil by filtration under pressure The application of refrigerating machines to this pur pose makes possible the treatment at one time of large quantities of petroleum As an example the works of Pardubitz in Bohemia are equipped with ma chines of a capacity of a million frigories and produce annually about four million (kilograms) of paraffin

The artificial silk called viscose is made by draw ing through very fine openings a thick solution of cellulose obtained with alkaline or sulpho-alkaline solvents (caustic soda and carbon disulphide) To accomplish this successfully the solution must be al lowed to stand in vessels cooled artificially to +2 deg C for a month or two before spinning The solution is then sufficiently pure to be decanted and spun with success

IV TRANSPORTATION WITH REFRIGERATION

The question of transportation of products under refrigerating conditions is one which has justly been a subject of careful consideration by transportation companies both on land and sea

The refrigerator cars or trains are of several types

(1) The refrigerator train consisting of a group of cars one of which has no capacity for storage but contains a complete refrigeration plant which feeds the other cars with which it is connected by suitable piping

The impossibility of breaking up such a train by uncoupling the cars from each other limits the practical application of these trains however except in a few instances This system was experimented with in 1905 in the transportation of Russian butter from Siberia (from Kourgane to Riga at a mean speed of 15 to 16 kilometers per hour) The cost of the re frigeration the temperature of the butter being main tained at a mean of 5 5 deg C was as high as 0 117 franc per kilogram of butter per day exclusive of the cost of the refrigerator plant

In this category must be classified the Russian re frigerator car of the Slitich system It is mounted on four sets of wheels on bogy trucks and is of the fol lowing dimensions Length 8 meters width 3 meters height 2 65 meters capacity 120 cubic meters It is divided into six compartments Two in the center contain the refrigerating apparatus while the other four may be charged with goods to be refrigerated

(2) The lack of elasticity of the refrigerator trains has been remedied by the use of refrigerator or in sulated cars The operation of these cars necessitates at the starting point an insulation composed of a re frigerating machine and an apparatus which forces a blast of cold air into the body of the car before and after charging When the interior temperature of the car has been reduced to the requisite degree the cold air is shut off and the car hermetically sealed In Springfield Mo there is an installation of this kind capable of cooling 40 cars of bananas at one time to 15 deg C

With this type of cars may be compared those where the low temperature is obtained by the previous cool ing of brine contained in coils about the roof o walls of the car The thermo regulator car of the Mak soutoff system belongs to this type The saline so lution which cools the air to about 5 deg C must be cooled every two days necessitating refrigerating sta tions every five or six hundred kilometers

(3) Besides the tributary cars of the refrigerator trains and those depending on an installation at the point of departure there are the self-cooling cars that is to say cars themselves containing cold produc ing agents These are the most universally used both in Europe and America

These may be divided into two great classes Cars cooled by ice and cars cooled by evaporation of a liquefied gas

In the ice-cooled cars the low temperature is ob tained by means of ice disposed in compartments along the roof as exemplified in the cars of the So ciété des Magasins et Transports frigorifiques de France or along the walls of the car as exemplified in the American cars and cars of the Moscow Kazan Railroad The plan of closing the body of the car completely from the outside air has been generally abandoned The ice cooled cars now in use are usu ally provided with an arrangement which draws in air from the outside and sends it after cooling it by contact with the ice to renew the air in the car The free space remaining for this disposition of the mer chandise is about 30 to 40 cubic feet allowing the in troduction of a load of from six to ten tons according to the nature of the products By an ice consumption of an average of 400 kilograms per day a temperature varying between 8 deg and 4 deg C is obtained The degree of humidity is high however

The cars cooled by evaporation of a liquid gas (in this case ammonia) carry on the outside two cylin drical tanks of liquid ammonia This fluid is sent by regulating cocks into coils placed at the two ends of the car on the inside The ammonia evaporates and absorbs heat the ammonia gas produced dissolving in water in a tank placed under the car One car of this variety was experimented with in 1905 in the transportation of butter from Siberia The cost of refrigeration for butter maintained at a temperature of from 4 deg to 5 deg C was as high as 0 068 franc per kilogram of butter per day

In the ice cooled cars of various types experimented with by the same Russian commission the total cost of refrigeration including all expenses (ice consump tion and charging installation of ice houses and op eration of cars) amounted to 0 009 franc per kilogram of butter

As the short summary I have just made shows the First International Congress of Refrigeration has ex amined with care most of the scientific and technical problems which exist in the refrigerating industry If it has solved any of these problems it has indicated in the form of resolutions a very great number of others which up to the present have been only incom pletely worked out The next international congress which will be held in Vienna in 1910 will not be in ferior to that at Paris and will bring us let it be hoped in the scientific phase to some accurate knowl edge of the properties of bodies at low temperatures and in the industrial phase to a uniformity of units of measure and methods of testing machines and in sulating material

Mica Production in India

By E Harran

India is at the present time the source of a little over half the world s supply of mica. During the five years 1904 to 1908 inclusive the quantity exported rose from 1 825 hundredweights to 41 256 hundred weights and the value from $415 915 to $1 237 680

Although a mica producing country itself the United States is India s best customer and of the total quan tity of mica produced in the Orient seventy five per cent goes to Great Britain which is the center of distribution for the States and Germany the latter country taking the next largest quantity after the former

The mica raised in India is the variety known as mucovite and is found in large pegmatite veins tra versing mica schists in various parts of the peninsula principally the east and south The two principal centers of production are the Nellore district in the Madras presidency and a tract of land about twelve miles broad and sixty miles long which stretches across the junction of the Gaya Hasaribagh and Monghyr districts in Bengal. In the latter of the two areas men tioned the mica industry is a very old-established one and can be traced back for several centuries In the former, however, the mining of the mineral was only started very recently, consequent on the discovery of rich deposits by prospectors employed by European capital. In this district the deposits occur in peg matite veins in granite, in micaceous gneiss in horn blende, and mica schists. The strata vary from a few inches to several hundred feet in thickness. These pegmatite veins (or "dikes" as they are sometimes called) consist of three essential minerals—quartz, felspar, and mica—in varying proportions In appearance they bear a resemblance to coarse granite, and the mica is usually found in those veins in which the constituent minerals have crystallised in large masses Where felspar and quartz are present in small masses the accompanying mica is usually of little value

The mica found adjacent to the surface is almost always soft and cracked quite useless for commercial purposes other than manufacture into the substance known as micanitte Clearer and better colored mica is reached lower down in the solid ground and as the tunnel reaches greater depths where the rock formation is harder and more uniform the mineral ex tracted improves in quality It is stated that in the United States no more than five per cent of the total yield of the mica mines is sheet mica In India how ever it is calculated that an average of ten per cent can be cut into plates the balance being either wasted or converted, in part into micanitte General experi ence shows that the mica mostly demanded from India by America is of the green and ruby colored varieties in sheets of three square inches and upward India actually produces the mineral in green, ruby, yellow white and amber colors These are divided into clear and spotted or stained varieties the clear ruby and clear green being the most valuable fetching as they do at present prices between $7,200 and $9 720 a ton Of the common varieties all sized sheets are readily obtainable at prices ranging from 18 cents a pound for 2 by 3 inches to $1 71 and 12 cents a pound for the larger sheets The presence of any metallic inser tions in the mineral renders it useless for insulating electrical purposes (for which the bulk of it is re quired) generally For these specific purposes the sheets must be flexible free from cracks capable of withstanding high pressure, and non-conducting. The Indian mines produce mica, conforming to this last specification, in large quantities.

The mica mines in Bengal are still worked in a very primitive way, in fact, in exactly the same method as they were worked centuries ago, when the principal use the mineral was put to was to fill the apertures of windows for which we now use glass The mica which generally occurs at the exposed outcrop on the hill face of a pegmatite vein is followed from book to book by underhand stopping which results in the production of holes some of which are now five hun dred feet deep The resultant material excavated con sisting of mica earth rock etc is brought to the surface by a string of native coolies being passed in cane baskets from one to another up rudely con structed bamboo ladders During the rainy season work is completely stopped for some three months say June July and August At other times when rain has occurred during the night the start of work in the morning is delayed for an hour or more while the resultant accummulation of water is being baled out by hand In Nellore and Mysore in South India min ing operations are carried out in a much more up-to date manner as a result of their more recent origin and the attention that European capitalists are direct ing to them

Dessau Gas for Balloons

It is but a short time since publicity was first given to the invention of a new method of producing a gas specially adapted for filling balloons The process was developed at the Deutsche Continental Gas Gesellschaft of Dessau and the name 'Dessau Gas has accordingly been applied to the product. A re port on some of the more recent developments in the new method is given by A Sander in Die Umschau The process consists in subjecting ordinary illuminat ing gas to a high temperature whereby the hydro carbons present are for the most part split up into hydrogen and carbon The reaction is one of that im portant class known to the chemist as 'contact ac tions that is to say it is greatly assisted by the presence of solid material offering a large surface to the heated gas

Accordingly in carrying out the process the gas

is led through retorts packed with small charcoal or coke (whose innumerable pores expose an immense surface to the gas) and heated to the proper temperature. The chemical change which takes place is accompanied by 20 per cent increase in volume. This together with the deposition of carbon which forms part of the change leads to a product very considerably lighter than the original illuminating gas. In fact its specific gravity, expressed on the basis of air as unity is about .2 to .3, whereas that of coal gas is between .4 and .5. The new gas therefore has considerably greater buoyancy or "lifting power" than ordinary coal gas. It contains about 80 to 84 per cent of hydrogen and 5 to 7 per cent methane, and is free from benzene and other hydrocarbons which attack the balloon cover. Its odor is rather more subdued than that of coal gas. The cost of converting illuminating gas into "Dessau" gas is quite low, hardly more than the cost of delivering the former under ordinary conditions from the works to the consumer.

Motor Truck for Hauling Building Stones

A New French Commercial Automobile

By the Paris Correspondent of the Scientific American

Of recent years automobile trucks have come into extensive use for hauling various heavy goods and we have seen an increasing number of cars placed on the market designed specifically for use in handling special classes of material.

Among cars of this kind we wish to illustrate one which has recently been built for handling heavy loads of cut stone for building purposes in Paris. The ordinary practice in such cases is to place the stone upon a timber rolling truck and draw it along the road. The car which is shown in our illustration is designed with special facilities for loading and unloading the truck with the greatest possible efficiency. In the form of truck used hitherto there was usually provided a swinging platform which could be let down to the ground and then drawn up with its load using a hand operated capstan for the purpose. To take a load of stone from the railroad depot or the quays of the Seine to the building site in the city used to require a team of five, six or more horses. The same load can be handled with an automobile truck at a much lower cost owing to the economy in wages, the elimination of the expenditure for maintenance of horses and the greatly increased hauling capacity per day. Another advantage which is well worth considering is the much smaller space which the conveyance occupies in the street, thus avoiding obstructions of the thoroughfare. These considerations have induced the association of building contractors and the Automobile Club to organize a prize contest for motor trucks. A set of rules were drawn up regulating the general design, dimensions, load, speed and other points. A road test was to be made outside the city over a thirty mile run without a load at ten miles an hour and a second test with the truck loaded with six tons or less, the cars being run in this case over a stated route within the city which included some steep inclines. The speed prescribed for this test was six miles an hour.

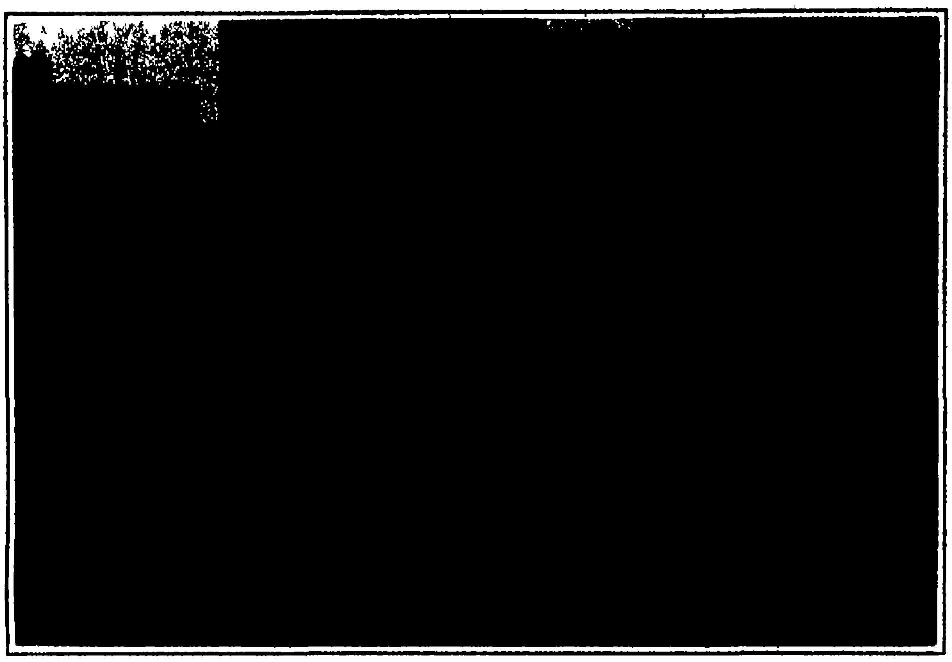
The motor truck described in these pages came out as the most successful competitor in this contest and received an award from the Commission. It is built by the well known French firm Creusot.

During the test just mentioned it carried a load of five tons representing an aggregate weight of nine tons over the route which included some grades of as much as 13 per cent, and gave complete satisfaction.

The spring wheels with which it is equipped give a very easy motion on the stone pavement.

This hauling car is made up of a main truck of the usual pattern for vehicles of this description to which is added a tipping platform that can be let down at the rear to discharge the load. Upon this tipping platform a roller truck travels which receives the load of stone or other material. On tipping the platform the truck rolls down of its own weight to the ground and is thus automatically unloaded. The platform is pivoted upon an axis located near the rear wheels of the automobile and some distance above the main axle. The pivot is mounted about the middle of the swinging frame but a little in advance of that point so that the platform when empty will automatically swing down at the back when its front end is released. The driver's seat is placed well forward and lies above the motor whereby space is economized and the total length of the car is reduced. Not counting the swinging frame the total length of the chassis is 15 feet 4 inches, the wheel base between front axle and rear axle is 11 feet. The wheels are of a new and special design and carry a set of broad steel tires placed over rubber rings extending between the tires and the hub. The diameter of the front wheels is 2 feet 10 inches and that of the rear wheels 3 feet 2 inches. The width of the tires is 4 inches in front and 7 inches at the back. The motor is of the four cylinder type with 5 inch stroke and 4 inch diameter. In normal working it gives 900 revolutions per minute and 30 horse-power. The fuel is either alcohol or gasoline, the tank being located under the driver's seat. The radiator is cooled by a blast of air thrown upon it by a fan and is located at the front of the car.

The tipping frame is built of longitudinal channel bars with a cross-stiffening of T irons. Along the side beams extends a T-iron which serves as a rail for the rolling truck carrying the load. In front these bars are curved upward to provide a buffer. An inspection of the drawing will show near the front end of the rolling truck two side plates perforated with round holes. These are provided to furnish a hold for inserting crowbars when loading and unloading. The platform, when loaded is held in place by a coupling link, which fastens it down upon the chassis at the front end.



THE CREUSOT MOTOR TRUCK. TAKING ON THE LOAD SECOND STEP

At one side of the chassis will be noticed the capstan which serves for loading and unloading. It is driven by bevel gears, one of these being placed in the circular space below the capstan and the second in the vertical gear case visible just in front of the same. On the shaft of the vertical gear is a sprocket wheel driven by a chain from the motor. To this end the second sprocket is mounted on one of the shafts of the speed-changing box of the car.

Underneath the capstan is a horizontal plate with projections which serve as a clutch to throw the capstan drum on or off the gear shaft. A ratchet and pawl serves as usual to prevent the capstan from slipping backward. A rope is wound around the capstan drum and is then coupled to the rolling truck, passing over a roller upon the tipping frame so that the load can be drawn up or else let down by the reverse movement. The operations of taking on the load or discharging it are easily carried out by using the present capstan device. To load the rolling truck with the stone upon the car, the swinging frame is tipped so that the rear end comes down upon the ground. Here the channel bars are cut off at an angle so as to give beveled ends in order that the truck may be readily rolled up. The cable is wound in a few turns upon the capstan and thence passes first around a sheave at the center and near the front of the chassis, and then down to be hooked to the front end of the roller truck. The capstan is thrown in gear by the lever of the clutch and the free end of the cable is drawn tight around the drum. As the capstan revolves the roller truck is drawn up, and when a certain point is reached the frame tips forward by the weight of the load and becomes lodged upon the chassis in a horizontal position. Continuing the operation, the roller truck is drawn to the forward end where its movement is limited by the buffers. It is held in this position by the link coupling which works as a guy coupler and is tightened down by a screw so that the truck is held firmly. The cable is [illegible] inches in diameter and a [illegible] load can be [illegible] at the rate of 1 foot per second. [illegible]

THE CREUSOT MOTOR-TRUCK. TAKING ON THE LOAD; FIRST STEP

to work with a heavier load than usual, say a weight of 6 tons, a pulley block is used with the cable so as to reduce the speed by one-half.

For the unloading operation, the capstan is made to draw the roller truck toward the rear of the tipping frame To this end a pulley is mounted at a point near the rear of the chassis, and the rope is wound around the capstan and passes from here to the rear pulley being then coupled at the rear end of the roller truck Working the capstan, therefore, gives the reverse of fect and draws the truck backward When it passes a certain point its weight causes the frame to tip down to the ground and the truck rolls down and off the frame To prevent the motion from becoming too sudden a braking action is given to the capstan by winding a few turns of a second rope on the free part above the main rope so that drawing upon it will slacken up the speed of the drum

The stone truck can be replaced by a box body adapted to hold any kind of material In this way the auto-truck can be kept in continuous service when there is no stone hauling to do. Commandant Ferrus, one of the members of the official commission con siders that this new car would be very useful in army work for quick transportation and handling of un mounted cannon

An Early Project for Wireless Telegraphy

It will probably be news to most readers that a wireless telegraph company was incorporated by act of Congress in the year 1873 The corporation was entitled the Loomis Aerial Telegraph Company and its members were Mahlon Loomis Alexander Elliott, and William N Chamberlain of Washington D C P R Ammidon of Boston and Isaiah Lukens of Delaware It was permitted to have a capital stock of \$200 000 and to increase the same to \$2 000 000 if the interest of the company should require

All that the act of incorporation tells of the purpose of the company is that the business and objects of said corporation shall be to develop and utilize the principles and powers of natural electricity to be used in telegraphing generating light, heat and motive power and otherwise make and operate any machinery run by electricity for any purpose"

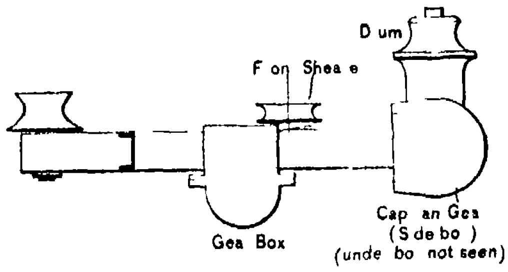
The Loomis Aerial Telegraph bill was introduced by Representative John A. Bingham of Ohio referred to the Committee on Commerce and thence favorably reported by Omar D Conger of Michigan on May 21st 1872 In Mr Conger's long and flowery speech the theory of the scheme was set forth as follows

"This theory assumes that the earth itself the atmosphere surrounding it and the infinite depth of space encompassing this aerial world contain a succession of concentric circles or planes of electricity of which those nearest the earth are perpetually disturbed by oceanic currents atmospheric changes alternations of day and night and the ever varying effects of solar radiation and lunar influences but that above these pierced perhaps by the tops of the loftiest mountains are concentric circles or vast sur rounding seas of undisturbed electricity which may be affected by any interpenetrating galvanic force from beneath causing electrical vibrations or waves to pass from that point within such electric plane around the world as upon the surface of some quiet lake one wave circlet follows another from the point of disturbance to the remotest shores So that from any other mountain top upon the globe any conductor which shall pierce this plane and receive the impression of such vibration may be connected with an indicator which will mark the length and duration of such vibration and indicate by any agreed system of notation convertible into human language the *messages* of the operator at the point of first disturbance and thus not only from one but many mountain tops piercing far above the circumambient atmosphere the devotee of science and the solemn student of nature may gather the unwritten messages of interest or affection from the silent solitudes of nature and the cerulean depths of heaven with unerring accuracy and transmit them to the denizens of all lands by the mundane machinery of telegraphic instrumentalities"

Mr Bingham more prosaically said I understand that the highest authorities on electricity both in America and Europe sustain the theory upon which this project is based to wit that the earth is negatively electric, and that the atmosphere above the earth is positively electric increasing in proportion as you ascend above the level of tide-water The project here proposed is simply to connect the air at a certain altitude (three or four miles if you please above the level of the sea) with the tide-water level of the earth by means of wires thereby completing the electric circuit."

Mr Bingham explained that the required altitude was to be reached by means of mountains that the company proposed "to utilize electricity wherever diffused through the earth and in the atmosphere of the earth for the purposes of light and heat and motion" (in addition to aerial telegraphy) and said that for three successive years he had introduced the bill and had it referred to the Committee on Commerce.

The principal opponent of the bill (Mr Charles W Willard of Vermont) objected to its passage on constitutional grounds, asserting that the power to incorporate belonged to the several States and that incorporation by Congress conferred an unfair advantage, and he was not moved from this position by the reminder that a telegraph company incorporated by Congress was actually operating wires from the Mississippi to the Pacific Most of the members of Congress, however appeared to regard the bill as some-



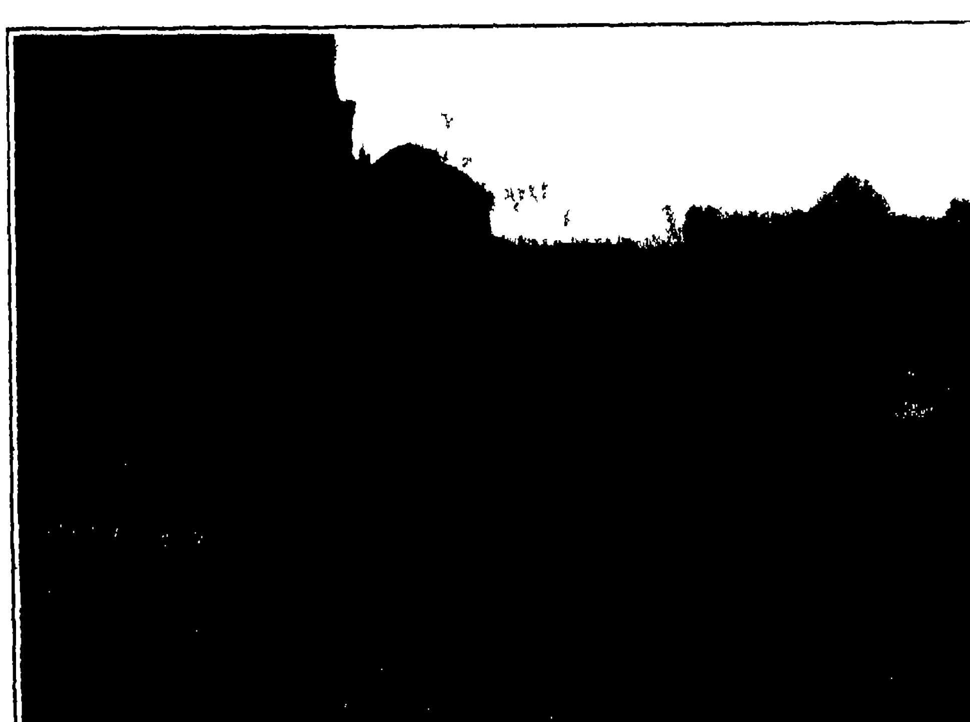
The Creusot Motor Truck—Details of the Capstan

thing of a joke and let it pass as harmless Yet this Congress the forty-second contained a distinguished array of men of great ability including in addition to those already mentioned James A Garfield (speaker *pro tempore* and subsequently President of the United States) James G Blaine (speaker) William P Frye Eugene Hale Benjamin F Butler Oakes Ames George F Hoar William H Barnum S S Cox Fernando Wood William A Wheeler (subsequently Vice-President) Samuel J Randall James B Beck Michael C Kerr Daniel W Voorhees Jeremiah M Rusk and others

On the day following the debate the New York *World* published a long editorial headed Airy Nothings filled with aggressive ridicule of the project and of "this electrical Conger whose name would lead one to suppose him a denizen rather of the water than of the air

This all happened thirty eight years ago How well may we learn at this time following the C Q D of the ill-starred Republic and the still more recent rescue of Wellman and his brave associates the value of some Airy Nothings of prophecy and the truth of Mr Conger's work Sir the visions of the seer are wont to be mistaken for the ravings of insanity The sublime revelations of prophecy as well as the announcement of important truths have oftentimes been deemed the vagaries of those whom much learning hath made mad

"This electrical Conger was the same man who urged the passage of the act which provid d funds and authority to send Gen Greely on his quest of



THE CREUSOT MOTOR TRUCK IN TRANSIT

the North Pole and in honor of whom Greely named Conger Inlet and Fort Conger celebrated as the abiding place of Greely and his men, and later of Peary and other Arctic explorers

A description of the actual conditions under which wireless telegraphy is commercially successful would differ little from the theory advanced in the debate on wireless telegraphy to which the House of Representatives listened "with dreamy indifference thirty-eight years ago

The Neglected Art of Mastication

The important part which chewing plays in nutrition is beginning to be recognized By thorough mastication the food is ground very fine and mixed intimately with saliva so that it is converted into a soft pulp which is then formed by the tongue into a bolus that is easily swallowed But the saliva the flow of which is increased by chewing has a more important f nction than lubrication It exerts a chemical action on the food converting its insoluble starchy co stituents into soluble sugars gluc se and maltose and the easily digested dextrin Mr Horace Fletcher has made himself famous by his advocacy of thoro gh masti cation and has raised chewing to a fine art He makes a study of flavors and hews his food ntil all its savor has been extracted and it glides down the throat spontaneously

With many of o r modern foods thoro gh mastication appears superfluous and we are apt to think it sufficient to cut the food into small pieces soften it with butter and sauces and wash it down with copious drafts of water and other beverages This artificial method is not an efficient substitute for the natural method of chewing and it produces decay of the teeth in addition to n merous digestive tro bles Teeth are or should be living tissues in which metabolism or renewal of s bstance is constantly going on If they are not used s fficiently they s ffer from mal n trition and lack of exercise and consequently decay With the decay of the teeth mastication becomes more imperfect and more neglected and th s the two evils poor teeth and poor chewing continually aggravate each other

Teeth need the exercise of chewing hard solid food Even children sho ld be allowed to eat the crust of bread and taught to chew this and other food thoroughly

The value of good teeth and the importance of a rational method of chewing wi l be demonstrated in vario s ways at the coming International Hygienic Exhibition in Dresden where it will be shown accord ing to *Hygieia*, the circular of the exposition that the action of the gastric juice is increased by thorough mastication of the food

A New Cement Compound

G ypri ith is a product patente l in Europe com posed of sand crushed stone and rapid setting Portland cement It is used for many purposes such as for facing upon almost any kind of material and especially upon concrete and it gives the appearance of stone The compound adheres strongly and can be easily washed No special tools are needed for p tting it on. Another use is for ornaments and these resemble stone s ch as relief work keystones capitals of columns etc Such ornaments can be made on the spot or produced beforehand and fastened in place when putting on the surface layer A reinforced concrete constr c tion treated in this way is said to present no difference from natural stone as to outside appearance and can be made as ornamental as desired being naturally much cheaper

The Reliability of Electric Furnaces

Factors in Their Development Under American Conditions

By F T Snyder

A few days since a man who had been in the East attending the meetings of an association of engineers representing an industry that uses a large amount of high grade steel in various forms was asked about the electric furnace paper on the programme He characterized it as the usual optimistic hopes by the agent of an electric furnace inventor But without the furnace inventors and without the optimistic hopes that held them for ten years to the expenditure of time and energy and money that was all outgo and results deferred there would be no commercial electric furnace work to-day to consider Moreover it now seems as though the time had come to point out to those who are less closely in touch than ourselves that the electric furnace has grown beyond a question of this or that inventor has grown beyond a question of hopes to one of commercial use and is now a matter of engineering and finance that to-day the electric furnace has achieved reliability

THE SIEMENS ELECTRIC FURNACE

But before the time goes by when particular arrangements of electric furnaces are named after their inventors as such time has gone by for the open hearth furnace and for the crucible furnace it would seem proper that we should call by the name of its inventor that simplest of all electric steel furnace in which a single electrode above leads the current through an arc to the steel and a metallic contact with the steel bath below leads the current back to the dynamo Back in 1880 so far back that the paper describing it was read before the Society of Telegraph Engineers then the only organization representing electrical engineering William Siemens built and operated his furnace in which the heat of the electric arc was used to melt steel This little furnace was a practical furnace It made good steel A duplicate of it copied from the old drawings will work to-day without difficulty making its little batch of steel It is especially fitting that to this same William Siemens the steel industry also owes its open hearth furnace only second in importance to the blast furnace itself

As the Siemens electric steel furnace was the first practical electric steel furnace so now it bids fair to be also the furnace to be used in the greatest numbers It is characteristic of the electric furnace that it is reliable in small units and it is in this direction that the industry is tending—the making of some steel castings by many of the gray iron foundries the making of their own steel castings by many of the larger users In these small installations the simplicity and reliability of the Siemens electric steel furnace will be important With proper engineering this single electrode type of steel furnace can be built reliably up to 500 kilowatts producing 250 tons of steel per month with continuous operation Many more than a majority of commercial installations will be below this tonnage A worthy use of this opportunity will be to emphasize the good to electro-chemistry that has lived beyond the life of this man by calling this type of electric furnace the Siemens furnace

COMMERCIAL RESULTS

Broadly reliability is commercial the ability to make a profitable return on an investment That the electric steel furnace is reliable in this way is emphasized by the growth of those plants in Europe that are making electric steel exclusively And beyond steel making the electric furnace has been commercially reliable so long in the aluminium industry that the general patents have run out The commercial reliability of the electric furnace in the manufacture of carbide has been for years in evidence with each user of acetylene light Less widely known but commercially profitable has been the electric furnace manufacture of carbon bisulphide of phosphorus, of graphite of abrasives of magnesium for flash lights of ferroalloys for steel refining and in the last few years we have seen the reliability of electric furnace operations pledged in the investments of the millions of dollars that are going into the construction of huge electric furnace plants for the production of fertilizers And it is the commercial reliability of these older electric furnace applications that is back of the reliability of the newer application of the electric furnace to steel In them was developed the demand that justified the building of electrode factories whose products are now available for steel furnaces In them was developed the special engineering ability to handle the large electric currents of furnace work They had their part in the demand for electric current at lower and lower cost It is these things that have given the Siemens electric steel furnace of thirty years ago a technical curiosity then, its standing to-day as a reliable industrial tool

Technically reliability is a matter of apparatus and men and supplies These react on each other Experienced and skilled men can force poor supplies and indifferent apparatus to a commercial output Apparatus that is inherently self regulating will permit the use of such men as can be had at a permissible cost Supplies that have a factor of safety in their constitution will carry the equipment through an over load Involved in the question of commercial reliability is the element of time Results must be prompt.

AN AMERICAN ELECTRIC STEEL INDUSTRY

To make electric steel in the United States means furnaces that are reliable with American men and American supplies In the rush of industry reliability cannot afford the time hazard of importation Europe developed the electric steel furnace industry first just as it developed the dynamo first, the steam turbine the large gas engine and steel making itself There the pressure of competition for opportunity the abundance of trained technical men and the low cost of capital force enterprise Safely we may look in America for the same swift overtaking of achievement with the electric steel furnace that has characterized other technical developments For this reliable American electric furnace supplies are now available and tested American electrodes can be had in sizes as large as furnace requirements call for Refractories made in this country have been developed with an ability to stand up well under the higher temperature of the electric teel furnace Campaigns with roofs of American brick have run into months as against weeks for European practice

Skilled electric furnacemen are scarce The rapid installation of furnaces more than absorbs the few who have had an opportunity to become experienced with electric furnaces working in commercial operation Trials with electric furnacemen imported have not been wholly satisfactory The drive of the American steel plant does not seem to fit with the methodical nature of the foreign technician This shortage of skilled furnacemen at permissible costs has thrown more of the burden on the apparatus has directed American electric steel furnace design toward inherent self regulation as we say electrically toward reliability as the investor looks at it toward making it fool proof as the man on the job phrases it Furnace detail that works very well in Europe with the skilled help available there has to be designed here to work with the help that can be had This inherent reliability can now be carried on to an extent that permits taking a steel melter from a crucible or open hearth furnace and putting him on an electric steel furnace with the assurance that within a week he can be making salable steel regularly This does not mean making an electrician of him Actually he knows no more of electricity than he knew of the kinetic theory of gases in his open hearth work but he does know that when the wattmeter needle is in a certain position he has a supply of heat in his furnace and hot heat at that and heat that, hot as it may be will not burn his steel

BETTER STEEL

But a reliable furnace and reliable supplies and reliable melters are not all of the commercial reliability of electric steel The steel produced is different from crucible steel It is different from open hearth steel If it were not different the electric furnace would not be used It is true that under favorable conditions steel can be made cheaper with an electric furnace than in other ways but the fundamental reason that is speeding electric furnace construction is that the steel is better Being better means differing chemically differing physically from the steels of the other furnaces and this difference chemically and physically must be reckoned with in the subsequent processes the steel goes through In the foundry the molding must be done for this new material It is freer from gases. It usually is hotter The tendency is to lower the carbon for the same tensile strength and this makes it set at a higher temperature. The improved elimination of phosphorus and sulphur tends in the same direction In the forge and rolls electric steel shows its additional strength and toughness

It must be handled from the point of view of its characteristics It is a mistake simply to consider the electric steel furnace as a substitute for some other kind of a melting furnace Its introduction can be counted on to mean changes of method as far as the steel is followed in manufacturing processes, and unless this is clearly recognized there will be disappointment and the reputation of the electric furnace for reliability will suffer

ELECTRIC FURNACE CONSTRUCTION NO EXPERIMENT

From a still narrower technical point of view, reliability means freedom from actual breakdown, from the enforced necessity of change in construction and the consequent loss of time and productive capacity As to this, electric furnace design is now on an engineering basis Dependence on experiment is now a matter of volition on the part of the investor It is no longer a necessity As a piece of engineering apparatus an electric furnace can now be more closely designed to meet narrow specified operating conditions than can an open hearth furnace

In a recent instance an electric furnace and a small open hearth were installed side by side in a new steel casting shop The open hearth gave trouble and has been replaced by a better design. The electric furnace although not of most modern design has operated without need of alteration Those details in which an electric furnace differs from established open hearth practice—the electrode holders, the electric regulation the contacts with the bath of steel—are now rugged and simple Electrode holders are in evidence that operate with less than one hour's lost time in a hundred beats

THE RECORD OF A WESTERN PLANT

Recently I have had occasion to examine carefully in detail the condition of a plant using electric furnaces exclusively that started operation on a commercial scale in the summer of 1907 and that is quite aged as electric furnace design goes It is proposed to double the size of the unit and increase the size of this plant fivefold and this examination was made to determine from the condition of the plant and the operating history what changes in the original design could be made to advantage in the extensions Incidentally the examination disclosed a condition of continuing reliability that is worth recording Substantially all of the original equipment was still in use The plant which is in the West has been operated since its installation by Chinese labor under a white superintendent, and neither the superintendent nor the Chinamen knew more of electricity than is involved in the opening and closing of circuit breakers and the reading of ammeters and voltmeters One of the power transformers had been replaced but it was learned after its removal that the trouble was an abraded spot on a terminal that could have been readily repaired on a Sunday at the plant. This particular plant while not a steel plant, is of interest in showing on many of its operating records a heat development efficiency of over 90 per cent—that is of the heat equivalent of the energy delivered to the plant by the high potential electric wires, over 90 per cent is transferred to the material under treatment

CHEAP ELECTRICITY A PRIME FACTOR

It is to be expected that the success of this new and flexible tool of industry will lead to over enthusiasm and to its application in wrong ways and in wrong places and that its failure as a panacea for troubles it has properly nothing to do with will bring setbacks But back of its present success is the cause of that success the steadily lowering cost of electric currrent Thirty years ago the furnace of Siemens worked as an apparatus It was not until the cost of current dropped below the figure at which the electric furnace was commercially reliable in this country that its industrial application began and its engineering side developed This dropping of the cost of electricity is still going on and as it goes on it brings a greater and greater motive force to bear on the installation of electric furnaces At the same time unfortunately for industry in general but fortunately for the electric furnace the cost of fuel for direct and gaseous heat is slowly but steadily rising.

Summed up more briefly the facts that an investigator of electric furnace results may expect to find are

1 That the electric furnace itself has passed from the field of experiment to that of engineering but that the fields of manufacture using the electric furnace products are still experimental

2 That the electric furnace is technically reliable and will operate continuously with the men and supplies that are available in this country That the details are simple and rugged, and that the inherent regulating powers can be made such as to bring it well within the ability of usual plant labor

3 That the electric furnace is commercially reliable That when installed with the same business care and adaptation to conditions that should be used with other furnaces, it will earn a profit on the investment, and a profit that is larger than the normal manufacturing profit in proportion as the field is more open

A paper read before the Chicago Section of the American Electrochemical Society

Art and the Engineer*

Combining the Useful With the Beautiful

By James P Haney

A SHORT time since New York city made a very extensive showing of charts and figures to explain to her citizens how she spent their money One room of this Budget Exhibit was given over to the work of the Municipal Art Commission Here were hung upon the walls a number of plans some of modest projects—a park fence a street lamp or fountain others of large and costly structure a memorial bridge a municipal ferry house a mile of river piers These plans were all in pairs and on one of every pair was stamped the word "rejected" on the other "accepted" These terse commentaries meant that the Art Commission whose business it is to pass upon every city building picture statue or engineering work had thrown out certain plans because of their artistic shortcomings Here was a very practical lesson on the value of art addressed particularly to the engineer

To the man trained in shop or laboratory the word "art" implies a rather hazy and indefinite something which has to do with the painting of pictures and the making of statues In a lesser way it is felt to be associated with the concoction of prettiness and the decoration of bonnets dresses and other feminine gear That on the contrary it is a very vital and practical thing underlying the successful development of huge commercial enterprises is an idea not grasped

Yet, in the exhibition to which reference has been made art appeared as an element which in one case led to an accepted plan and a busy firm and in the other to a rejected design and an idle office In neither case did the decision depend upon the engineering knowledge involved The shortcomings were not structural but artistic Two plans of equal merit from an engineering point of view were not of equal value in the eyes of the commissioners It was their business to select the project which was better in design—that is better in artistic relations To understand something of these relations and how they are created must then be important in the training of one who is later to play the part of a creator and builder of structures large and small

The development of city art commissions is only a new expression of a very old desire It is the effort of a town's people to secure beauty in their surroundings and this search for beauty is as old as man Of all human instincts there is none deeper than that which leads man to adorn the things he possesses to decorate his person his tools and all his belongings This desire says Carlyle is the first spiritual longing of the barbarian The savage who dwelt in the dim dawn of history has left us no trace by which we can know him save the drawings with which he decorated his stone cave His successors as they have struggled upward through the ages have in turn left results of similar desire to beautify things in jewels in carvings in temples and in tombs

Art has thus meant many things to many men but after all can be best defined as the search for beauty and beauty is something which does not lie without but within us It is our own response to that which stirs us it is a personal thrill and is in us and not in the thing which moves us Herein is art's great secret we can know no beauty that we do not feel Art is dependent upon appreciation born of an emotion To make such appreciation sensitive to fine forms beautiful lines and harmonies of color its lessons must be taught early in the life of the worker It is not a thing that can be gained in a few lessons or lectures as a minor part of some complex curriculum It is something which must be secured through an effort actually to create fine forms—an effort extended over a series of years through which the student has by criticism and comparison of his work with that of master craftsmen learned to refine his taste and to respond—to thrill—to harmonies ever more and more subtle

One who is to learn what art is must come to understand as his first lesson that it is not something apart and unrelated to him something to be raised by others for him to admire Rather it is that which he can create himself indeed something which he must create himself even in the simplest business of his life The decoration of a room the hanging of pictures on a wall the choice of colors in clothes and furnishings, all are of everyday experience yet they call for just the knowledge of what makes for beauty in line and form. And this same knowledge is daily required throughout the business world No office can be equipped, no advertising matter printed no lofts arranged for the sale of goods or windows devised for their display without appeal to these same principles

To learn thus, that art is common is not to learn that it is commonplace There is a luxury of taste which far surpasses the luxury of wealth The latter cannot by extravagant expenditure secure the results which are attainable by practice in choosing between things esthetically good and bad Choose however we must every day and many times a day and each choice is a matter of judgment Such judgment is born of discrimination We call it taste To realize this is to realize that we are all designers and that we must make pattern every time we dress ourselves equip an office or as engineers or architects plan the simplest of constructed forms

Art thus seen is plainly no unnecessary extra to be tacked upon the course which the engineer studies but a very practical subject which rightly taught, will color his judgment and give him breadth and insight far beyond his unschooled fellows It is something which deals with design both constructive and applied Its principles are those which underlie all good arrangement fitness to purpose proportion unity and harmony The laws of design based on these principles apply just as truly and surely to the planning of a bridge of mighty span as to the pattern of a door handle or a gas fixture They apply just as surely to forms we deem unimportant—the factory stack or the gutter curb as to the monuments and parkways which are a city's pride

Not until the student has grasped these principles of design does he come to realize how far the engineer controls his audience how far in others words one who understands movement balance and rhythm of lines and masses masters the eye of the observer and makes it look where he will It is this knowledge which guides the architect in his arrangement the sculptor in his grouping the painter in his composition With it Le Page in his Joan of Arc by a score of subtle devices fastens our gaze upon the face of the warrior maid We can look away but for a moment and in a trice some branch or shaft of light or shadow brings us again to the focus of the picture—to the eyes filled with the divine vision

Design may thus work miracles It can dignify the plainest of work by elegance of form and proportion It can ennoble the simplest of materials in structures fine in mass and color It is within its power to make that which is light seem strong and substantial to make that which is heavy yet seem instinct of a joyous and dynamic spirit The latter is the power which resides in the mighty cathedral of Beauvais whose huge piers lose the crushing sense of weight and break into columns which spring between the painted windows and draw the eye up past the lights of the clerestory into the shadows above where dim pictures of angels and saints hint of a heaven higher still

Art it has been said has meant many things to many men The student of shop and laboratory who would learn something of its stimulus and power must not be content then to look only at the work of engineers or architects Man has an inheritance of which great buildings monuments roads and aqueducts are only a part For centuries art has permeated the life of every country Our understanding of the past—of the Egyptians the Greeks the Romans and the Teutons all who lived around the Mediterranean and the Baltic and all of whose dynasties rose and fell in the mysterious East—has been gotten from their search for beauty The work of long-dead artists now fills our museums and forms our artistic legacy It is art's contributions from the past to the work of the artisan of to-day

This art heritage is to be read in the treasures of a host of kingdoms whose artisans in metal and in ivory in clay in glass in silk have dignified craft work and made it precious through their search for beauty in its working Every material which could be woven, tempered spun chased or tooled has had in art's history the lifelong study of many master craftsmen The very difficulties of its working have been made the pleasure of minds that delighted to find new ways in which it might be made to serve art's purposes To understand this heritage—to read it aright—is to gain a sympathy with those who through a hundred generations have made art the sovereign mistress of their daily work and have served her with lifelong devotion

Out of this wonderful legacy there stands forth for the engineer structures willed to him as a special inheritance These may well serve to thrill his heart and stimulate his admiration for his forbears and their work For him the pyramids temples and obelisks spell a lesson which the untaught may not read the Acropolis stands as a chapter printed in gold and all the seven hills of Rome as a great volume written by artist engineers. For him the great churches of France and Italy of Spain and England and the Low Lands speak the patient working out of trying problems in the hard school of experience the long dykes of Holland tell of the will and skill of a wise and courageous people the great châteaus of France of men happy in their power of wedding use and beauty Through these lessons he can learn to read the devotion the toil the aspirations triumphs and failures of those who have gone before As the heir of the ages he now of age himself may enter into his own

There is another lesson for the student who studies the structures of the past As the work of men long gone now teaches him so he must remember that he will play the part of teacher to those who are to follow Just as he is designer despite himself so of necessity he must become instructor to all who are to see his creations He may design well or ill and so be a helpful teacher or a vicious one But teach he must the very size and publicity of his work make it impossible for him to escape If it be beautiful it will impress its lesson upon every member of the community As fine monument well proportioned building gracefully springing viaduct or soaring tower it will subtly and surely increase the pleasure of all who see it If it be ugly and ill adjusted to its surroundings squat and heavy in its form or weakly decked forth with small and busy ornament it will help debase the taste of all who know it

The young engineer dreams of some great project which may later be delivered to his hands—some huge bridge some great terminal building a dominating tower or a stately church Art warns him that if his dream come true it will be his to create that which may either be a delight to all who see it or something which because of ugliness will be a blight upon the city The bad picture we may hide the ugly park we may replan but the structure of steel or stone or brick or concrete remains to hearten or to haunt us

Art then is at once a personal asset of its possessors and an immense civil and national asset when expressed in the work of the engineer Thousands go abroad to see fascinating cities reared by the labor of artist and artisan These cities profit in no small measure because of the beauty which their architects and engineers have created Their people delight to show the stranger what knowledge and affection have done to dignify great markets highways parks and avenues There is both an economic and a civic moral in this And of the two the civic is the more significant The engineer whose work is to find place even among the crowded tenements can yet help by his building to add to the pride of those who rejoice that they are citizens of no mean city Of this pride is born a keener feeling in her welfare a more loyal devotion to her interests and a quicker sensitiveness to all that does her ill

Yet another quickening force appears in the relation of art to the engineer In all things is a duality We live as well in a world spiritual as in a world material Not only esthetic lessons but spiritual ideas breathe forth from the work of one inspired by art Thus in the hands of the engineer art in the past has preached many sermons Every religion has called upon it for aid and every faith has seen its hopes made visible in temple shaft and aspiring pinnacle Strength sobriety sublimity are ideas as well to be expressed in steel or stone as in the spoken word

Through the spiritual insight which Art gives the beauties of Nature are to be read in a new language Her moods of pearly dawn of gray and rolling cloud of mystery of night and splendor of the storm are for those whose sense has wakened to the thousand lines and hues in which she paints her patterns and in which she tells the story of the living world The fascination of this its endless variety are first for those who through art's training have learned to look upon Nature with sympathetic eye—with the painter's vision—which sees beauty in the foggy dripping wood land and stunning force in the heave and thrust of a huge shoulder of a wave drawing past a headland in the sea

These things of the spirit once felt cannot but enter into a man's work be it never so simple and never so confined If he feels them they will speak for one can but talk the language of his mind If one thinks small thoughts his work will surely be mean and cramped If he responds to man's noblest efforts and to Nature's noblest teaching his creations cannot but reflect this inspiration Art for the engineer as for painter sculptor or architect for craftsman writer or musician is the talisman the spell which sets the spirit free Through it the worker may learn that which for ages has been the keenest spur to labor—the delight in service which seeks to praise God through one's craft

* A lecture delivered before the Stevens Engineering Society

Modern Coal Cutting Machinery and Mine Railways

Remarkable Labor-Saving Devices

By Frank C Perkins

MODERN coal mines are now equipped with many most remarkable labor saving devices operated electrically and by compressed air including coal cutting machines p n hers and mine haulage engines The d tails of construction of the electrical equip n nt a d con rol of mining locomotives as utilized in modern pr tice are of special interest Various types of su h lo omotiv s are in use differing more or less in ap arance and structure A good general view of two exampl s is shown in Figs 1 and 2 of our illustrations The former represents a 10 ton electric lo omotive delivering bituminous coal out of the rooms of th mine of the Hitchman Coal an l Coke C mpany

In the view reprod ced i Fig 2 a 12 ton Jeffrey lo omotive is seen delivering a train load of coal from the mines of the St Bernard Coal Company to the tipple In very low mines and where b it a few cars are handled six ton locomotives are frequently employed while for heavy service in the haulage of long trains of heavily loaded cars large locomotives of 16 tons are us l At the mines of the Westmoreland Coal Company where extra heavy service is required the locomotives reach a figure of 30 tons They are eq ipped with three motors whose electrical connections are indicated in the accompanying drawing Fig 3

The series wound electric motors are electrically connected so that the same current passes through the armature windings and through the field windings A flexible cable conducts the current from the trolley harp to a fuse or circuit breaker as a protective device inclosed non arcing fuses being usually employed with a lightning arrester connected between the trolley harp and the fuse when the mining locomotives are operated outside of the mines to any great extent or distance

From the protective device the electric current is conducted to the controller the electrical connections of which are indicated in the accompanying drawing (Fig 3) The controller includes a cylindrical switch for throwing resistance into and out of the motor circuit and also a reversing switch for changing the direction of the current through the field of the motor and the armatures in order to reverse the direction of travel of the locomotive

Usually a series-parallel switch is arranged in connection with the reverse switch so that the motors may be connected either in parallel or in series as desired

When the power house is located at considerable distance from parts of the mine the line loss is often so great in distant sections that the motors when connected in series will not receive enough current to start heavy trips and in fact with motors connected in series it is possible for one of the motors to start to slip its wheels before the other motors start The explanation of this is that as soon as one of the motors starts to slip its wheels it sets up a counter electromotive force which reduces the current flowing and the result is the other motor does not get sufficient current to develop any great effort, consequently the loads cannot be started With motors connected in parallel each motor takes current independently of the other and each exerts its full effort.

The operation of the controller is as follows The first resistance contact which comes under its brush permits current to flow through all of the sections of resistance coils in series thence through the motors to the rail or in case of a double trolley system to the other trolley wire The second resistance contact coming under its brush bridges the first section of resistance The third resistance contact coming under its brush bridges the first and the second section of resistance and so on until all the sections of resistance are bridged and the full electromotive force of the line is applied directly to the motor terminals From the resistance at the controller the current flows to the reversing and series-parallel switch This switch usually consists of a wooden cylinder inside of the controller case to which are fitted copper segments engaging with the contact brushes which are the terminals of the motor leads

Electric power is held by many mining engineers

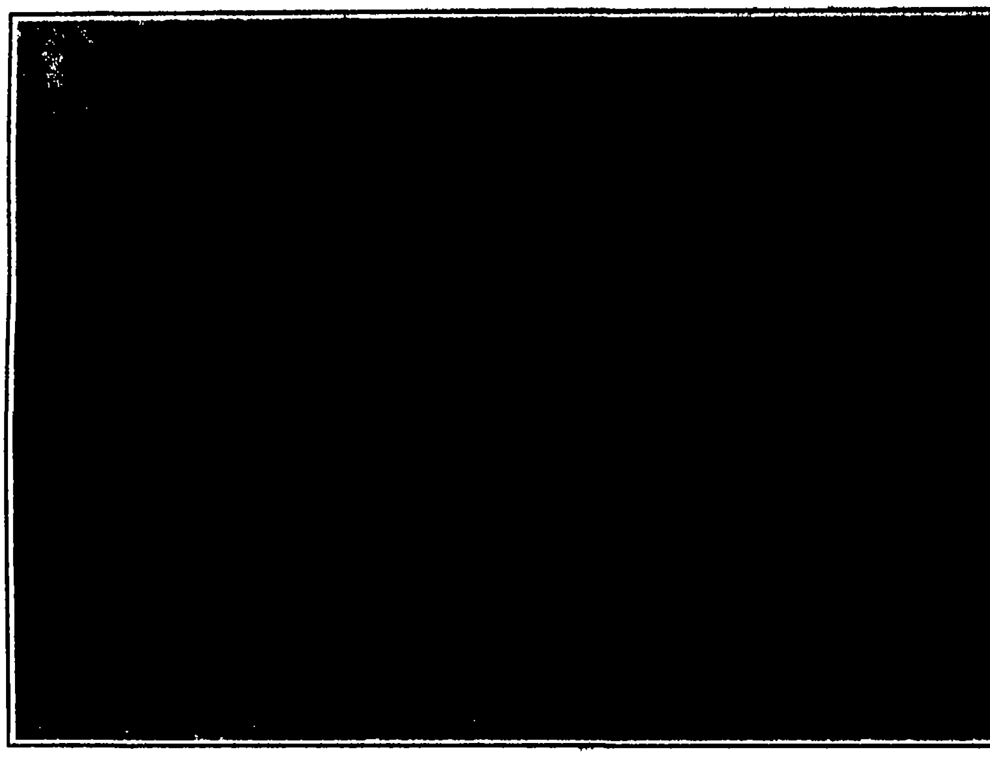


FIG 2—TWELVE-TON ELECTRIC LOCOMOTIVE OF THE ST BERNARD COAL COMPANY

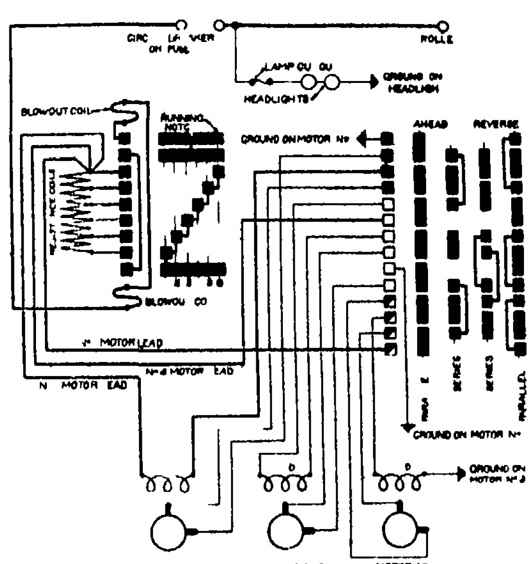


FIG 3 DIAGRAM OF CONNECTIONS OF THE THREE-MOTOR TWENTY TON ELECTRIC LOCOMOTIVE OF THE WESTMORELAND COAL COMPANY

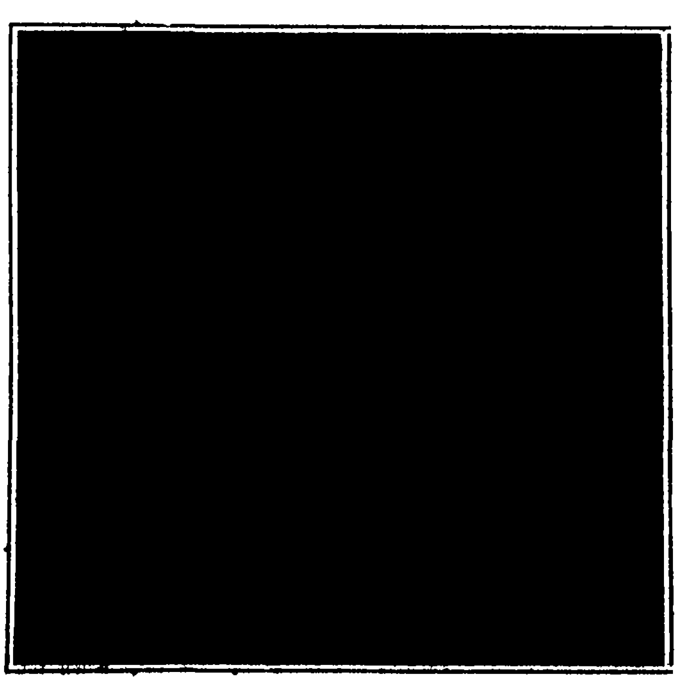


FIG 4—JEFFREY ELECTRIC COAL CUTTER

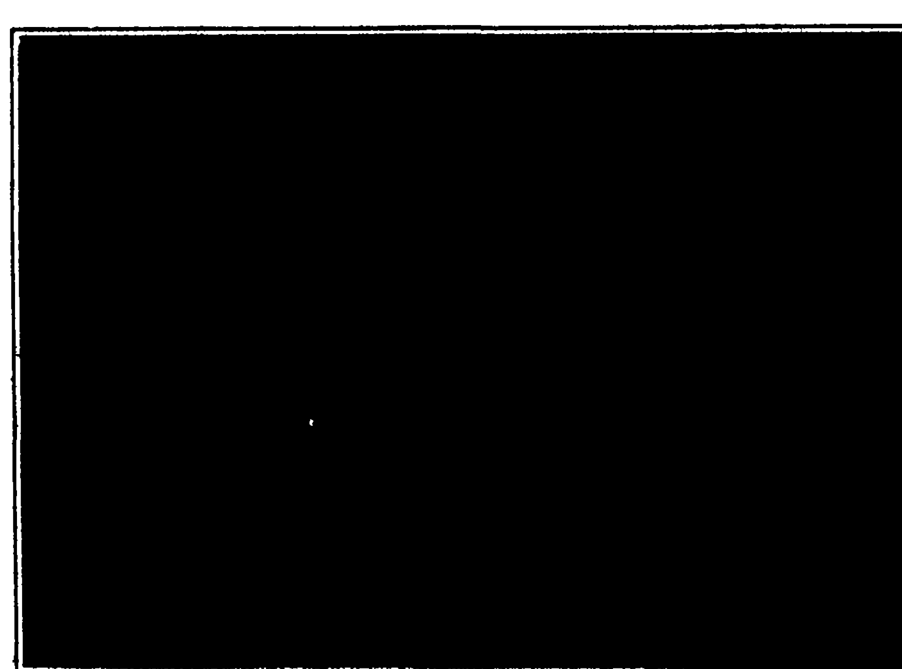


FIG 5—JEFFREY PNEUMATIC COAL CUTTER AT WESTMORELAND MINE

MODERN COAL-CUTTING MACHINERY AND MINE RAILWAYS

the most economical and satisfactory power for heavy service coal cutting in modern mines, and it may be of interest to consider the method of operation of these labor-saving devices as utilized in a mine of the new Pittsburg Coal Company. The accompanying illustration (Fig. 4) shows a heavy electric coal cutter of the Jeffrey type in the operation of starting a cut in this mine. In the design and construction of such electric coal cutting machines all parts are made interchangeable to insure quick repair as the machines are required to withstand very rough work and the abuse incidental to mine service.

The cutter chains must be of great strength in order to resist the sudden and excessive strains and the wearing parts must be specially proportioned to insure the longest life possible while the electric equipments are required to have ample power to withstand the most severe work with great overload capacity.

The openings in the chain links are arranged at such angles that either chisel or straight pick pointed bits or combinations of both may be used according to the character of the cutting.

As the depth of the under cut should always approximate the thickness of the vein the lengths of the cutter frames are usually 5, 6 and 7 feet while the width of the cutter head for breast machine is generally about 44 inches. In some instances a 39 inch cutter head is utilized where the cuting is hard or when for any other reason a narrow head is preferable. With these electric coal cutters the speeds of the feed and pull back can be varied to obtain the largest output consistent with the hardness of the cutting and for this class of service electric power is in almost universal use being economical in operation and effective in working allowing a great output for the amount of energy expended and the time labor and money invested.

Air power coal cutters are extensively used in the mine of the Westmoreland Coal Company. A machine of this kind is displayed in Fig. 6 at the mine entrance. It is mounted on a steel truck so designed that the cutter may be loaded and unloaded with minimum effort and loss of time. In Fig. 5 an air power cutter of the Jeffrey type is shown just starting the last cut at the right hand rib in the Westmoreland mine. It is of interest to note that this machine was designed for use in mines where ventilation is a perplexing problem owing to gas and dust and also in mines where compressed air plants had been installed prior to the application of electricity for underground use. The solid build and resistance to wear of this machine have caused its adoption for a large number of mines where the cutting is hard and being of the chain type it makes less fine coal and less dust than other air machines in service. Pneumatic coal cutters similar to those shown in the accompanying illustration have been operated to special advantage at the mines of the Massillon Coal Company and also in a rather different class of work for cutting cement limestone in the mine of the York Portland Cement Co.

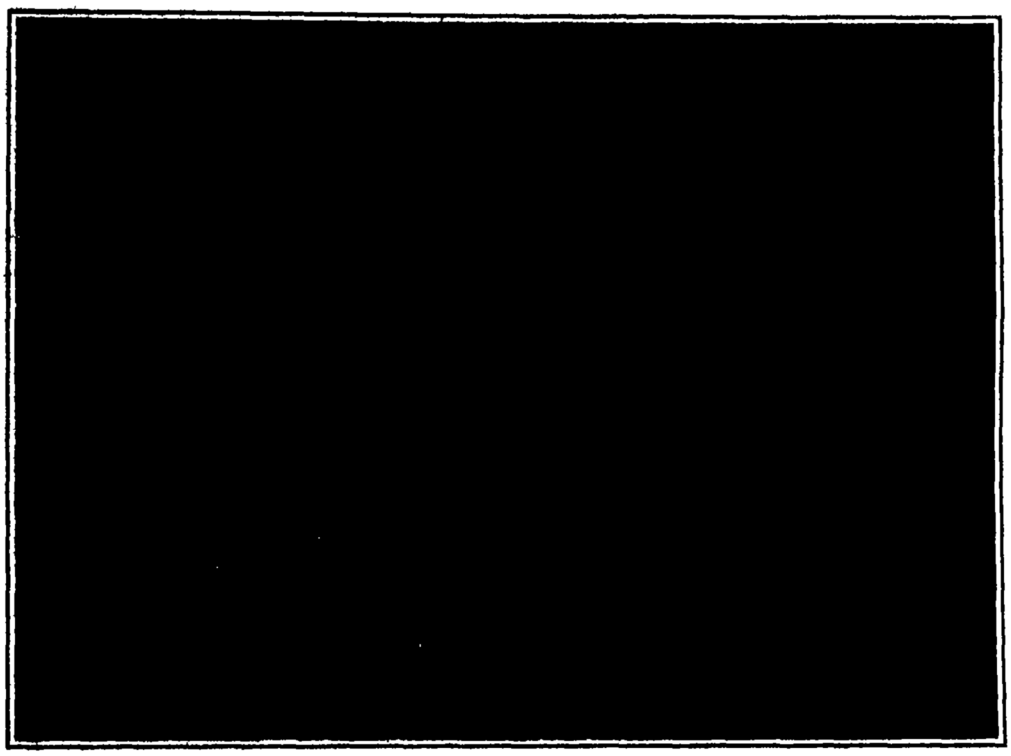


FIG. 6.—PNEUMATIC COAL CUTTER.

The early machine coal cutters driven by compressed air were of the cutter bar type as distinct from the chain type now commonly used and had cylinders set vertically on the frames or carriages. There have been modifications and improvements made from year to year for the last four decades as the demand for the machines increased, and new conditions in mining developed until the form illustrated known as the air chain mining machine was evolved. There are to-day only two distanct types of air coal cutters in use, one commonly known as the puncher and the other that mentioned in the foregoing.

It is generally conceded that there are in the United States certain mining districts where the "puncher" machine can be used to greater advantage than the chain or breast type and this occurs where poor roofs necessitate propping very close to the face or where rolls are met with in the mine and the coal is frequently cut out or in mines where an excessive amount of sulphur in the form of sulphur balls occurs in the bottom of the veins where the cuting is to be done. In the majority of mines however where the conditions of mining are normal chain or breast type of machines can be more advantageously and economically used than the puncher.

Pneumatic mining machines are designed for five six or seven foot undercuts and for seams under five feet in thickness. The five foot undercut is commonly employed while for seam ranges from five to six feet the undercut generally desirable is six feet and for thicker seams seven feet.

In this construction the cutter head can be either thirty nine or forty four inches wide and for all ordinary cutting the forty four inch cutter head is used but when the cut is extremely heavy the thirty nine inch head is preferable. Either chisel or pick point bits or a combination of both can be used to suit the character of the coal to be cut and various speeds of feed and pull back are arranged to suit local conditions. The machines are provided with the necessary jacks to hold them in position and with trucks adapted to the track gage. For the air hose about fifty feet of one and one half inch wire wound pipe with couplings is commonly employed.

The air machines have of course a special advantage in places where air power is already installed as they can be put into operation without changes in power equipment or pipe line.

While compressed air puncher machines are used extensively in mines in many instances electric power only is available. In such cases the so-called pneumatic electric puncher is operated with great economy. This mining machine which is shown in operation in Figs. 7 and 8 consumed only 7½ horse power whereas machines of older design and construction having an equal cutting capacity require from 20 to 30 horse-power.

While the application of the electric motor for driving the chain machine was comparatively simple for the rotative motion of the motor readily lent itself to driving the chain through the medium of gears the problem of adapting a motor to give reciprocating motion to a pick was far more difficult of solution.

In a percussive tool the vibrations if transmitted directly would be more or less destructive to the electric motor and while the problem has been considered from almost every conceivable point and upon every conceivable basis experience has practically demonstrated that in order to give sufficient flexibility the blow itself is best struck through the medium of compressed air. In the electrically driven puncher a compressor cylinder is used and unique means of compressing the air have been devised.

The driving motor is of the ordinary series wound four pole type. The shaft of the motor is vertical

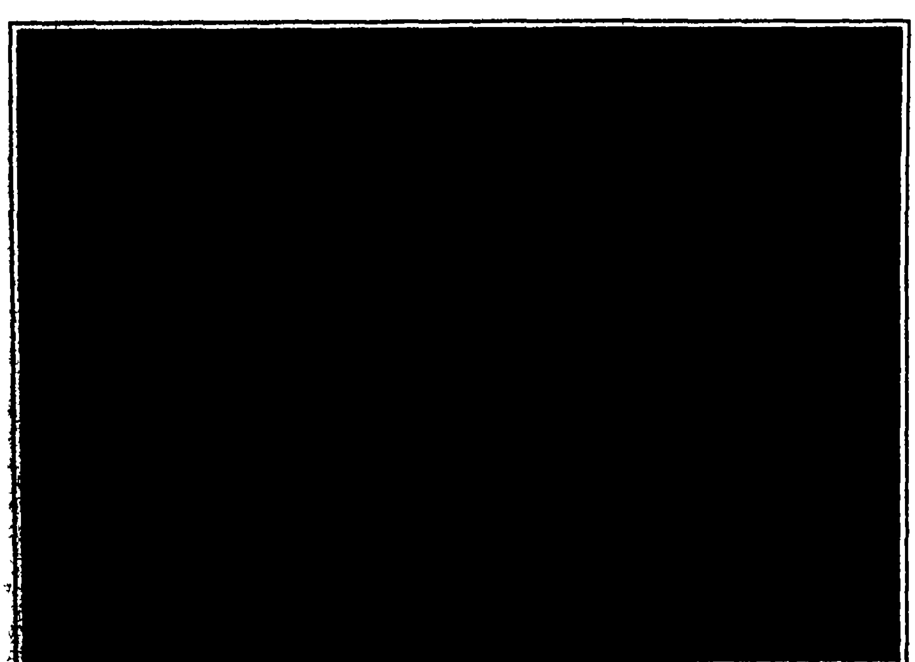


FIG. 7.—A PNEUMATIC ELECTRIC PUNCHER. VIEW SHOWING BIT.

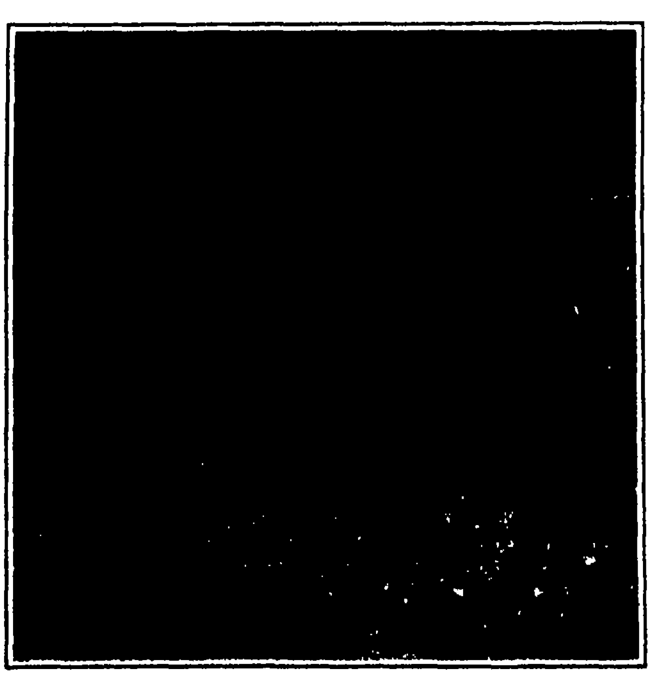


FIG. 8.—A PNEUMATIC ELECTRIC PUNCHER. REAR VIEW.

MODERN COAL-CUTTING MACHINERY AND MINE RAILWAYS

and the latter is completely inclosed, the frame and gear case cover being made in one piece of cast steel giving strength minimum weight, and simplicity

The support of the upper or commutator end of the motor shaft is furnished by a radial ball bearing while at the lower end is provided a ball thrust bearing to take up the weight of the armature and also a long bronze bushed bearing to take up the lateral thrust due to the motor drive

On account of the necessity of employing an inclosed motor the question of ventilation and cooling of the various parts became an all important matter It is accomplished by the very simple expedient of drawing the air to be compressed in through the armature and field windings at each forward stroke of the air compressing piston By this means about 28 cubic feet of cool air per minute passes over the heated parts at a velocity of about 2½ feet per second This method has been found very effective and is at the same time entirely automatic requiring no auxiliary appliances

The circular motion of the motor is by a novel and peculiarly simple arrangement of gears transformed into the straight line motion of the primary or air compressing piston located in a cylinder at the forward part of the machine. In the same cylinder is a second piston, connected with the striking pick, but having no mechanical connection with the first. Under the influence of the air which is compressed by the first piston and delivered through the open ports controlled by the same piston the second piston is alternately driven backward and forward but always prevented by the air cushion from striking at either end of the stroke

The extent to which the pneum-electric machine has been introduced has fully demonstrated its usefulness under all conditions of mining In hard or soft coal thick or thin veins, bad or good roof rolling or level bottom and narrow or wide work it has made records which place it at the front and its performance under these variable conditions has been such that it can justly be classed as a machine entitled to consideration as one of the most important factors in mining equipment.

The thrust due to the weight of the large reducing gear and its shaft, is taken up as in the case of the armature upon a ball bearing and the lateral thrust is resisted by a long bronze bearing which extends the entire length of the reducing gear shaft

The electric pneumatic puncher as noted in the illustration, Fig. 7, is provided with a reel and cable, the latter being used for conducting the power from the main and cross entries to the face of the coal. The cable is wound on the reel in such a way that connection can be made to the machine and entry wires, without unwinding more than sufficient cable to reach from the entry to within a short distance of the machine From this point the power is conducted to the machine, by means of a short cable varying in length from 30 to 50 feet. The long cable is of the twin type, the same as commonly used about mines in connection with other electrical machinery, except that it is unusually well protected from danger of injury by the hard service which it is required to withstand

It will be seen that this equipment is a great convenience as by using this cable it becomes unnecessary to carry wires to the face of the coal in the entries and narrow work. Piping, which is required in connection with air machines, is avoided, and the only permanent lines for transmitting the power are the copper wires which are strung in the main and cross entries. The same wires are also used for furnishing power to haulage locomotives, pumps, drills coal cutting machines etc.

Environment and Heredity

Modern Studies in Experimental Evolution

By Dr D T MacDougal, Ph D, LL D

Desert Laboratory Carnegie Institution of Washington

It is unanimously agreed that organisms plants as well as animals change individually in aspect in form and structure of organs in function and habit as they encounter swamps saline areas gravelly uplands or slopes climatic differences identifiable with latitude or elevation and other physical and biological factors It is generally assumed that these somatic alterations are accommodative and adaptive making *the organism more suitable for the conditions* which produce the changes Such an assumption is an over reaching one Any analysis of the changes which an organism undergoes after transportation to a new habitat will disclose one of a few alterations which might be of advantage in dealing with the newly encountered conditions but with these are many others direct necessitous atrophic or hypertrophic as to organs which have no relation whatever to usefulness or *fitness* Further a critical *examination* fails to disclose any theoretical considerations or any actual facts which would connect inevitably the somatic response with the nature of the excitation outside of the specialized tropisms in which specific reactions are displayed Even in these the adjustment is of such nature that a mechanism specially perceptive to contact for example may react to changes in temperature as illustrated by tendrils and many similar cases might be cited *It is evident that the soma of a* plant or animals is not to be considered as capable of adaptive alterations to every new agency which may cause changes in its form structure or function ation

Recent events in the field of evolution comprehend a number of movements and accomplishments of extraordinary interest The rediscovery of the facts of alternative inheritance the formulation of the concepts of equivalent balanced paired or differential characters the results of statistical studies of variability the analysis of species of various constitution by pedigree cultures in which the value of fertilization from various sources is carefully measured the distinction of the biotype or genotype as an hereditary entity the possibilities in the action of pure lines within a specific group the cytological contributions of fact and forecast upon the physical aspects of heredity and lastly the presentation of the facts and allowable generalizations identified with the mutation theory comprise series of advances of accretions to knowledge furnish a broadened foundation for biological science and disclose additional possibilities in all lines of experimental research with living things beside opening up new realms for speculative thought and stimulating the scientific imagination to renewed fruitfulness Nothing in the whole field of biological research surpasses in importance the problems as to inheritance of environic effects or as generally stated 'the heredity of acquired characters a subject which enlists additional attention from its specific sociological bearing

Among the most noteworthy investigations of environmental effects are those being made by the anthropologist in which somatic calibrations of immigrating races and linguistic studies of peoples of known origin geographical movement, and established relationship are being used to great advantage No more fascinating chapters of scientific literature are to be found than those which delineate the migratory movements segregations and habitual reactions of Polynesian islanders of North American Indians or of Asiatic peoples yet their value as actual contributions to biology is hardly recognized The investigator of problems in anthropology has the advantage of dealing with an animal whose psychology history traditions and records are readily intelligible to him so that a much wider range of facts may be brought within the zone of reliability than when we deal with an organism whose actions are but imperfectly understood

If a general view be taken of the available information of interest in this connection three classes of facts will be discerned One group is comprised in the mass of information obtained by the operations of the horticulturist the agriculturist and the breeder as to the behavior of crops plants and domestic animals when *transferred from one habitat to an* other The greater part of such data is the result of observations which do not comply with the ordinary requirements in the avoidance of error so that strict comparisons as to the behavior of organisms under the conditions of various habitats are impossible A consideration of the literature yields many suggestions for experimental research and the simple generalization that the direct effects of climatic complexes *on the seasonal cycle* and upon *color or structural fea*tures of the individual may be repeated or carried over two or three generations in a habitat where the specific casual combinations are lacking This is the available total of knowledge furnished us by economic operations and by the introduction operation of botanical gardens and plantations

A survey of the activities of the biological laboratories of the world during the last five years reveals the fact that an enormous amount of attention is being paid to the subject and that already results of very great importance to the student of evolution have been secured The nature of these contributions and the increase of information accruing from them may be best illustrated by a citation of some of the more notable experiments

Pringsheim after a comprehensive review of his own work and of other available evidence obtained by a study of accommodations or adaptations of yeast and bacteria to unusual temperatures culture media, and poisons concludes that some of these variations are fixed and transmissible both asexually and by spores while others are not There are a number of records of the appearance of definite qualities or morphological characters in the yeasts, which are transmissible and permanent These departures were so striking as to be capable of being regarded as mutational and their origin has been ascribed to the influence of the environment by experimentors of notable skill, such as Beijerinck, Winogradsky Lepeschkin Hansen and Barber It may be recalled in this connection that environic responses are generally sudden, and that the entire range of departure may be made in a single generation, at most in two or three.

Klebs who has long been concerned with the morphogenic reactions of plants, has determined a series of conditions under which the stages of mycelial development asexual zoospore and sexual or oospore formations in filamentous fungi may be inhibited or variously interchanged Much more important reactions were obtained from *Sempervivum* the live-for ever of the garden. In this plant, dense rosettes or propagative bodies are formed at the ends of some branches and inflorescences were replaced by single flowers by experimental excitation The number and arrangement of the floral organs as well as of the stamens and carpels could be altered Furthermore the deviations in question were found to be transmissible to the second or third generation in guarded seed reproductions

The results of Woltereck with *Daphnia* a small crustacean offer something by way of contrast and also serve to illustrate the necessity for continuation of parallel cultures for the purpose of comparison of divergent forms and the normal The particular group of this crustacean furnishing the experimental material is taken to be very variable and it was subjected to over feeding with the immediate result that the variability of the form of the head appeared to be widened the size of this structure being increased This disappeared when lots from the culture were restored to normal conditions in the earlier stage of the work After three or four months of over feeding the form of the head came within narrower limits and fewer *aberrants* were seen while lots returned to normal conditions showed a slower restoration of the original form of the head Two years after the cultures were begun it was found that the original head form was not displayed by young restored to normal nutrition conditions the larger helmet being persistent. It seems fairly certain that a new genotype resulted from the long-continued action of the culture medium

The fortunate experience of Zederbauer with Capsella has yielded some conclusions of exceptional importance A genotype of *Capsella Bursa-pastoris* resembling *taraxicifolium* was found on the lower plains of Asia Minor and displayed the well known characters of this form, including broad leaves, whitish flowers, and stems 30 to 40 centimeters high A highway leads from these regions to a plateau at an elevation of 2 000 to 2 400 meters. The conditions of distribution are such as to indicate that the plant has been carried up this thoroughfare by man, and in this elevated habitat it has taken on certain alpine characters including elongated roots, xerophytic leaves stems 2 to 5 centimeters high reddish flowers, with a noticeable increase of the hairiness of the entire plant. That the distributional history has been correctly apprehended seems entirely confirmed by the fact that when seeds are taken from the lowlands the alpine characters enumerated are displayed at once as a direct somatic response. When seeds are taken from plants on the elevated plateau where their ancestors may have been for many years or many centuries (perhaps as long as 2,000 years) and sowed at Vienna and in other cultures carried through four generations the leaves lose their xerophytic form and structure but the other characteristics are retained within the limits of variability The stems show an increase in average length of 1 or 2 centimeters the roots change as much, but the reproductive branches and floral organs retain their alpine

[illegible] The slight modifications undergone by [illegible] were seen to reach a maximum and to [illegible] in the latest generations cultivated. The [illegible] changes and implied functional accommodations are indubitably direct somatic responses there is no escape from the conclusion that the impress of the alpine climate on the soma has been communicated to the germ-plasm in such manner as to be transmissible and the suggestion lies near that repeated and continued excitation by climatic factors may have been the essential factor in such fixation

My own earlier work with relation to this subject consisted chiefly of ovarial treatments in which the [illegible] and accessory reproductive elements of seed [illegible] were subjected to the direct action of solutions of various kinds New combinations of characters [illegible]ting a distinct elementary species or genotype [illegible]ined in one plant and the divergent type has [illegible] to transmit its qualities in the fullest [illegible] as tested to the fifth generation Still [illegible] forms were obtained in a second genus, [illegible] progeny being lost in transference to [illegible] laboratory, while marked responses have been obtained in the extensions of these experiments upon species representing widely different morphological types in Arizona The greater majority of the tests have been made upon plants growing under natural conditions so that environmental reaction in addition to that of the specific reagents might be excluded Progenies representing many species including thousands of individuals many of which are divergent are now under observation Absolute finality of decision with respect to the standing of the new types may be reached but slowly

Gager produced chromosomic aberrations in the reducing division of *Oenothera* by irradiations and such excitation was also followed by the appearance of aberrants in the progeny the hereditary qualities of which have not been tested Using similar excitation Morgan induced the appearance of white eyes and of short wings in a pedigree culture of the fly *Drosophila ampelophila* But qualities were sex limited and mendelized when paired with the red eyes and long wings of the original type Both, however seem to be fully transmissible The first results of importance from cultures widely extended geographically have been obtained in the experiments with Leptinotarsa by Tower in which various species of these potato beetles were studied in their habitats in southern Mexico in open air and glass houses as far north as Chicago as far east as the Atlantic and as far west as the Desert Laboratory New self maintaining forms resulted from climatic excitation and the origination of species already in existence was repeated the varied effects secured being the most important contribution yet made to the subject

In addition to the conclusive observations cited there is available a great mass of information concerning experiments in which negative results were obtained the environment failing to produce any permanent effect while in other cases the living material has not been followed through a sufficient number of generations to test its heritability Thus Kammerer carried out some tests with salamanders three years ago that have the interest attached to any attempt to interpret geographic or habitat relations *Salamandra maculosa* is viviparous when it lives high in the mountains and ovo viviparous at lower levels *S atra* is an alpine form and the larvæ are large with very long gills When the latter form was kept at unusually high temperatures the larvæ produced resembled those of *S maculosa* in its lower warmer habitats. *S maculosa* kept in low temperatures and without water showed a cumulation of effects by which the characters of the young and the reproductive habits resembled those of *S atra* The conditions of these experiments are not such as to allow a definite separation of somatic and germinal effects neither was the permanency of the newly acquired habits tested to such an extent as to determine their hereditary value

In the experiments of Sumner, mice reared in a warm room were found to differ considerably from those reared in a cold room in the mean length of the tail, foot, and ear, and the differences were transmitted to the next generation The differences may be reasonably designated as being directly individual and somatic, and as having been transmitted by the germ plasm, which was not subject to the action of various temperatures in the first instance The reaction forms have an additional claim upon our attention since they are the ones which distinguish northern and southern races of many animals The crucial test of the value of the alterations induced in the mice is the one applicable to all of the experimentation on this subject a test in which two parallel series of cultures, one under the altered environment and the other under casual conditions should be kept going continuously for a long number of years lots being withdrawn from both from time to time for long continued comparative culture in normal habitat and under other conditions Effects due solely to fluctuating variability may be expected to reach a maximum and minimum within two or three years leaving the enduring effects standing alone or in such relief as to be capable of ready calibration

No little interest attaches to the evidence now accumulating to show that the hybrids between two species of plants or animals may be different in various localities or under the influence of special exciting agencies DeVries has repeatedly called attention to the fact that the composition of hybrid progenies of mutants with each other and with the parental form might be altered by nutritive conditions and the author has cited the fact that mutations were made by *Oenothera Lamarckiana* the great evening primrose in the climate of New York which had never been seen in Amsterdam Furthermore in discussing the divergent results of DeVries and myself obtained by crossing the same forms in Amsterdam and New York the suggestion was made that the manner in which the various qualities in the two parents are grouped in the progeny might be capable of a wide range of variation Many indications lead to the suggestion that the dominancy and prevalency latency and recessivity of any character may be more or less influenced by the conditions attendant upon the hybridization the operative factors might include individual qualities as well as external conditions

Tennent arranged a series of hybridizations of Echinoderms at Tortugas which yielded data of great interest in connection with the earlier conclusions of Vernon Doncaster and Herbst as to the influence of temperature and season changes upon dominance From the information derived from crosses of Hipponoë and Toxopnoustes it is clear that the dominance of the parental characters is dependent upon the alkalinity or the concentration of the OH ions The products of the trial cross fertilizations however were not reared to maturity

Much more striking evidence upon the matter has been recently obtained by Tower in intercrossing *Leptinotarsa decemlineata L multilineata L oblongata*, and other species of the potato beetles in their habitats in southern Mexico and at the desert laboratory Among other divergences one of the three first generation intermediates characteristic of these cultures was lacking from the Tucson cultures although two other such forms were included

In a comprehensive treatment of the entire subject with especial reference to modifications in dominance Tower says The experiments and observations herein given warrant the general statement that conditions external to a cross are important factors in determining the results thereof This conclusion has been worked out in both normal and hybrid crosses in crosses between races which have been created selectively, and between forms which arose as sports and the second series of experiments in synthesis is sufficient warrant for attributing to this factor a considerable importance in evolution

It is evident from the foregoing facts that the biologist is in a position to assert that external factors may affect the hereditary quality of plants and animals in a very marked manner and that agencies of various kinds may influence the results of crossing two species Furthermore the experiences at hand justify the assumption that the actual transplantation of organisms from one locality to another as a method of experimentation promises the results of highest value and widest significance especially when taken in connection with analytical laboratory cultures This method of approach is one which may yield evidence of the greatest value upon the influence of isolation and other geographical factors but is also one which allows the repetitive or mnemonic effects to be evaluated When supplemented by laboratory analyses and cultures to determine the nature of alterations induced such methods promise results of the greatest value

A series of plantations including locations from mountain tops to the seashore has been established in connection with the Desert Laboratory in accordance with this idea and in addition to the interchange of species from the various localities a number of introductions have been made from eastern America

None of the attempts hitherto made to perfect a theoretical conception which would be useful in interpreting the mechanism of environic responses have had anything more than the most limited usefulness The stimuli of climatic and many other agencies do not imply the introduction of any strange or new substances into the bodies of the organs affected These agencies might change the dissociations in such a manner as to modify the relative number of free ions and thus alter the molecular complex of the living matter in a very important manner The intricate play of enzymatic action might also be altered and any modification of the relative reaction velocities of the more important processes might result in material and permanent change especially in those cases in which external agencies interfere directly with the action of the germ plasm

The introduction of solutions into ovaries or the exposure of reproductive elements to unusual irradiation may arise from the additional liability of disturbed polarity and of modified surface tensions in the cells It is conceivable that the rearrangement or disturbance of the localizations of substances especially the mineral salts might seriously modify the capacities of the bearers of heredity These direct and material possibilities offer an adequate basis for the organization of experimental research upon the main subject as well as the means of interpretation of results without recourse to schemes of particulate inheritance or theories as to the constitution of germ plasm to which may be ascribed usefulness in the discussion of other problems in evolution

The various experimental methods used in the work on the subject and the diversity of the results obtained makes it possible to formulate some useful generalizations which may briefly be stated as follows

It is clear that some environic effects are heritable and some are not Negative or positive results of sufficient inclusiveness to permit analyses as to the nature of the exciting agency and the permanence of the response are not yet available Some of the induced characters may be retracements or regressions as the reappearance of spines in cacti or they may be awakened latencies or organizations de novo Some of the responses may result in sexual dimorphism while in others the induced characters may be sex limited The alterations induced by external agencies may be cumulative or mutative as to appearance or organization and they may be permanent upon first appearance or on the other hand may need generations of repetition before becoming fixed And lastly the changes may be orthogenetic or heterogenetic as to direction adaptive and accommodative or correlative or wholly inutile as to their functional relations

Clamp for Washing Negatives

By Z C Komorowski

The washing of paper negatives is a very delicate operation especially if one wants to do it very thoroughly without spoiling them and at the same time wash the hyphosulphite of soda entirely out We illustrate herewith a little tool which will do the work very effectively, and which commends itself on account of the cheapness and the ease of construction

Take a cork, cut it in half lengthwise, then from one of the halves cut a piece off the top as in Fig 1. Take a rubber band and fasten it tightly around the lower part of the cork to keep the two halves well together and insert a pin in the top of the uncut half, Fig. 2 The cork cut in this way will act as a clamp and the two halves can be opened more or less as desired

To use this clamp open it by pressing lightly the top insert the paper in the lower opening and then release Put the whole in the wash basin The cork

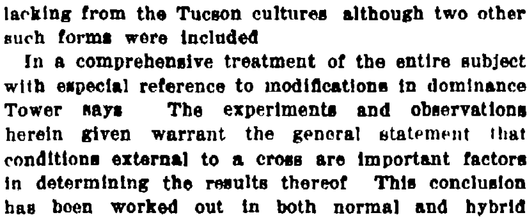


Fig. 1 Fig 2 Fig. 3

Clamp Made of Cork for Use in Washing Negatives

will float on the surface and the hyposulphite will dissolve and sink to the bottom After you are sure that the washing has been properly done, pick up the cork and the negative and hang them by the pin to drip on a wire or cord stretched between two supports (Fig 3)

From the time the negative is inserted in the clamp until it is taken out dry one need not touch them with the hands thus avoiding the danger of a scratch or a blotch

Inspection of nursery stock imported into the United States from foreign countries has been an important item in the year's work Much of this stock destined to many of the States and the District of Columbia when inspected was found to be seriously infested with brown tail moths or other injurious insects and nearly 300 such shipments have been destroyed Through the efforts of the Agricultural Department some of the offending countries have adopted inspection methods and their shipments are likely to be less dangerous in the future

Making Money Out of Bees—II*

Keeping Bees for Pleasure and Profit

By E F Phillips, Ph D, in charge of Bee Culture, Bureau of Entomology

Concluded from Supplement No 1833, page 110

DIRECTIONS FOR GENERAL MANIPULATIONS

Bees should be handled so that they will be little disturbed in their work As much as possible stings should be avoided during manipulation This is true not so much because they are painful to the operator but because the odor of poison which gets into the air irritates the other bees and makes them more difficult to manage For this reason it is most advisable to wear a black veil (Fig 4) over a wide brimmed hat and to have a good smoker (Fig 1) Experienced bee keepers often dispense with these but the beginner should not Gloves however are usually more an inconvenience than otherwise Gauntlets or rubber bands around the cuffs keep the bees from crawling up the sleeve It is best to avoid black clothing since that color seems to excite bees a black felt hat is especially to be avoided

The bee keeper should manipulate without exhibiting fear This is not because the bees recognize the fact that the operator is afraid of them as some claim but because superfluous quick movements tend to irritate the bees The hive should not be jarred or disturbed any more than necessary Rapid movements are objectionable because with their peculiar eye structure bees probably perceive motion more readily than they do objects Persons not accustomed to bees on approaching a hive often strike at bees which fly toward them or make some quick movement of the head or hand to avoid the sting which they fear is to follow This is just what should not be done for the rapid movement even if not toward the bee is far more likely to be followed by a sting than in remaining quiet.

The best time to handle bees is during the middle of warm days particularly during a honey flow Never handle bees at night or on cold wet days unless absolutely necessary The work of a beginner may be made much easier and more pleasant by keeping gentle bees Caucasians Carniolans Banats and

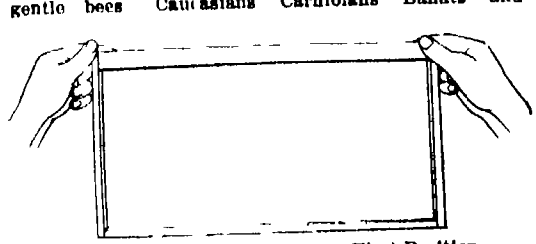


Fig 11—Handling the Frame First Position

strains of Italians ordinarily do not sting much unless unusually provoked or except in bad weather Common black bees or crosses of blacks with other races are more irritable It may be well worth while for the beginner to procure gentle bees while gaining experience in manipulation Later on this is less important for the bee keeper learns to handle bees with the least inconvenience to himself or to them

Before opening a hive the smoker should be lighted and the veil put on A few puffs of smoke directed into the entrance will cause the bees to fill themselves with honey and will drive back the guards The hive cover should be raised gently if necessary being pried loose with a screw-driver or special hive tool As soon as a small opening is made more smoke should be blown in on the tops of the frames or if a mat covering for the frames is used the cover should be entirely removed and one corner of the mat lifted to admit smoke It is not desirable to use any more smoke than just enough to subdue the bees and keep them down on the frames At any time during manipulation if they become excited more smoke may be used Do not stand in front of the entrance but at one side or the back

After the frames are exposed they may be loosened by prying with the hive tool and crowded together a little so as to give room for the removal of one frame In cool weather the propolis (bee glue) may be brittle. Care should be exercised not to loosen this with a jar The first frame removed can be leaned against the hive so that inside there will be more room for handling the others During all manipulations bees must not be mashed or crowded for that irritates the colony greatly and may make it necessary to discontinue operations Undue crowding may also mash the queen If bees crawl on the hands they may be gently brushed off or thrown off

In examining a frame always hold it over the hive, so that any bees or queen which fall may drop into it. Freshly gathered honey also often drops from the frame and if it falls in the hive the bees can quickly clean it up whereas if it drops outside it is untidy and may cause robbing If a frame is temporarily leaned against the hive it should be placed in a nearly upright position to prevent breakage and leakage of

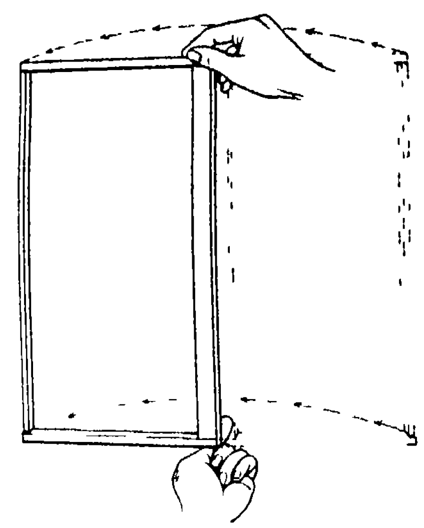


Fig 12—Handling the Frame Second Position

honey The frame on which the queen is located should not be placed on the ground for fear she may crawl away and be lost It is best to lean the frame on the side of the hive away from the operator so that bees will not crawl up the legs

In handling frames the comb should always be held in a vertical position especially if it contains much honey When a frame is lifted from the hive by the top bar one side is exposed to the operator with the comb placed vertically (Fig 11) To examine the reverse side raise one end of the top bar until it is perpendicular (Fig 12) turn the frame on the top bar as an axis until the reverse side is in view and then lower to a horizontal position with the top bar below (Fig 13) In this way there is no extra strain on the comb and the bees are not irritated This care is not so necessary with wired combs, but it is a good habit to form in handling frames

It is desirable to have combs all of worker cells to reduce the amount of drone brood The use of full sheets of foundation will bring this about and is also of value in making the combs straight, so that bees are not mashed in removing the frame It is extremely difficult to remove combs built crosswise in the hive and this should never be allowed to occur Such a hive is even worse than a plain box hive Extra inside fixtures should be avoided as they tend only to impede manipulation The hive should also be placed so that the entrance is perfectly horizontal and a little lower than the back of the hive The frames will then hang in a vertical position and the outer ones

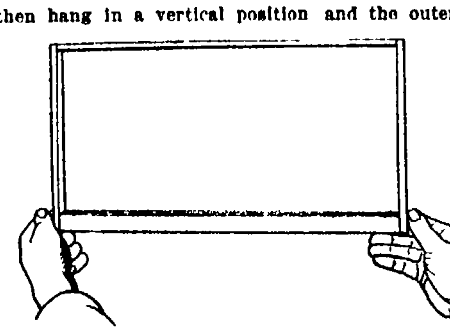


Fig 13—Handling the Frame Third Position

will not be fastened to the hive body if properly spaced at the top

Various remedies for bee stings have been advocated but they are all useless The puncture made by the sting is so small that it closes when the sting is removed and liquids cannot be expected to enter The best thing to do when stung is to remove the sting as soon as possible without squeezing the poison sac, which is usually attached This can be done by scraping it out with a knife or finger nail. After this is done the injured spot should be let alone and not rubbed with any liniment. The intense itching will soon disappear any irritation only serves to increase the after swelling

In placing frames in the hive great care should be exercised that they are properly spaced. Some frames are self spacing having projections on the side, so that when placed as close as possible they are the correct distance apart. These are good for beginners or persons who do not judge distances well and are preferred by many professional bee keepers. If the spaced frames are used they should be 1⅜ inches from center to center A little practice will usually enable anyone to space quickly and accurately. Careful spacing is necessary to prevent the building of combs of irregular thickness and to retard the building of pieces of comb from one frame to another

A beginner in bee keeping should by all means, if possible visit some experienced bee keeper to get suggestions in handling bees. More can be learned in a short visit than in a considerably longer time in reading directions and numerous short cuts which are acquired by experience will well repay the trouble or expense of such a visit. Not all professional bee keepers manipulate in the very best way but later personal experience will correct any erroneous information Above all personal experimenting and a study of bee activity are absolute necessities in the practical handling of bees

TRANSFERRING

In increasing the apiary it is sometimes best to buy colonies in box hives on account of their smaller cost and to transfer them to hives with movable frames This should be done as soon as possible, for box hive colonies are of small value as producers. The best time to transfer is in the spring (during fruit bloom in the North) when the amount of honey and the population of the colony are at a minimum.

Transferring should not be delayed until spring merely because that season is best for the work It may be done at any time during the active season but,

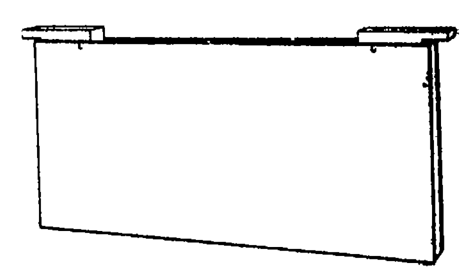


Fig 14—Division board Feeder to be Hung in Hive in Place of Frame

whenever possible during a honey flow to prevent robbing If necessary it may be done in a tent such as is often used in manipulating colonies By choosing a time of day when the largest number of bees are in the field the work will be lessened

The box hive should be moved a few feet from its stand and in its place should be put a hive containing either full sheets of foundation or empty combs The box hive should be turned upside down and a small empty box fitted on it. By drumming continuously on the box hive for a considerable time the bees will be made to desert their combs and go to the upper box and when most of them are clustered above the box may be carried to the new hive and the bees dumped in front of the entrance The queen will usually be seen as the bees enter the hive, but, in case she has not left the old combs more drumming will induce her to leave It is necessary that the queen be in the hive before this manipulation is finished The old box hive containing brood may now be placed right side up in a new location and in twenty-one days all of the worker brood will have emerged and probably some new queens will have been reared These bees may then be drummed out and united with their former hive mates by smoking the colony and the drummed bees vigorously and allowing the latter to enter the hive through a perforated zinc to keep out the young queens The wax in the box hive may then be melted up and any honey which it may contain used as the bee keeper sees fit. By this method good straight combs are obtained If little honey is being gathered, the colony in the hive must be provided with food

If, on the other hand the operator desires to save the combs of the box hive, the bees may be drummed into a box and the brood combs and other fairly good combs cut to fit frames and tied in place or held with rubber bands, strings, or strips of wood until the bees can repair the damage and fill up the breaks,

* Farmers Bulletin No 397 United States Department of Agriculture

[illegible] then be hung in a hive on the old [illegible] allowed to go in. The cutting of [illegible] brood with more or less bees on [illegible] job, and since the combs so ob[illegible] of little value in an apiary the [illegible] recommended

[illegible] take up their abode in walls of [illegible] necessary to remove them to [illegible] melting combs If the cavity in [illegible] built can be reached the method [illegible] that of transferring, except that [illegible] practical and the bees must simply [illegible] smoke and the combs cut out with [illegible]

[illegible] which is often better is to place a [illegible] the entrance to the cavity, so that [illegible] out, but cannot return A cone of [illegible] inches high with a hole at the [illegible] enough for one bee to pass will serve [illegible] or a regular bee escape such as are [illegible] may be used A hive which they can [illegible] placed beside the entrance The queen is [illegible] this way and, of course, goes right [illegible] but as the colony is rapidly reduced in [illegible] brood decreases As brood emerges the younger bees leave the cavity and join the bees in the hive, until finally the queen is left practically alone. A new queen should be given to the bees in the hive as soon as possible and in a short time they are fully established in their new quarters After about four weeks, when all or nearly all of the brood in the cavity has emerged the bee escape should be removed and as large a hole made at the entrance of the cavity as possible The bees will then go in and rob out the honey and carry it to the hive leaving only empty combs. The empty combs will probably do no damage, as moths usually soon destroy them and they may be left in the cavity and the old entrance care fully closed to prevent another swarm from taking up quarters there.

In transferring bees from a hollow tree the method will depend on the accessibility of the cavity Usually it is difficult to drum out the bees and the combs can be cut out after subduing the colony with smoke

UNITING

Frequently colonies become queenless when it is not practicable to give them a new queen and the best practice under such conditions is to unite the queenless bees to a normal colony If any colonies are weak in the fall even if they have a queen safe wintering is better insured if two or more weak colonies are united, keeping the best queen Under various other conditions which may arise the bee keeper may find it desirable to unite bees from different colonies Some fundamental facts in bee behavior must be thoroughly understood to make this a success

Every colony of bees has a distinctive colony odor and by this means bees recognize the entering of their hive by bees from other colonies and usually resent it If, however a bee comes heavily laden from the field and flies directly into the wrong hive without hesitation it is rarely molested In uniting colonies the separate colony odors must be hidden and this is done by smoking each colony vigorously It may at

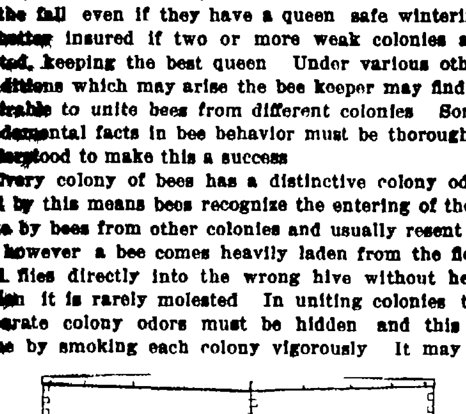


Fig. 15—Feeder Set in Collar under Hive Body

times be desirable to use tobacco smoke which not only covers the colony odor but stupefies the bees somewhat. Care should be taken not to use too much tobacco, as it will completely overcome the bees The queen to be saved should be caged for a day or two to prevent the strange bees from killing her in the first excitement.

Another fact which must be considered is that the bees of a colony carefully mark the location of their own hive and remember that location for some time after they are removed If, therefore two colonies in the apiary which are not close together are to be united, they should be moved gradually nearer, not more than a foot at a time, until they are side by side so that the bees will not return to their original locations and be lost. As the hives are moved gradually the [illegible] are noted and no such loss occurs. As a [illegible] a board should be placed in front of the entrance [illegible] position, or brush and weeds may be thrown down so that when the bees fly out they recognize the fact that there has been a change and accustom themselves to the new place If uniting can be done during a honey flow there is less danger of loss by bees fighting or if done in cool weather when the bees are not actively rearing brood, the colony odors are diminished and the danger is reduced

It is an easy matter to unite two or more weak swarms to make one strong one for during swarming the bees have lost their memory of the old location are full of honey and are easily placed wherever the bee keeper wishes. They may simply be thrown together in front of a hive Swarms may also be given to a newly established colony with little difficulty

PREVENTING ROBBING IN THE APIARY

When there is no honey flow bees are inclined to rob other colonies and every precaution must be taken to

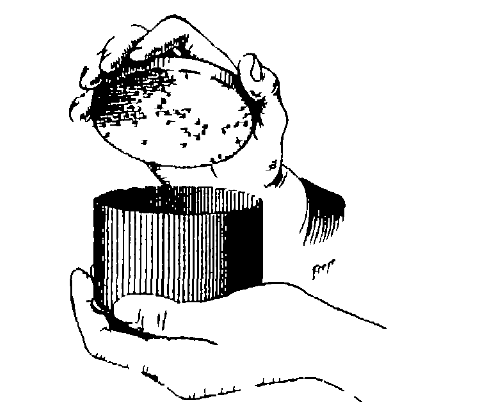


Fig 16—Pepper box Feeder for Use on Top of Frames

prevent this Feeding often attracts other bees and if there are indications of robbing the sirup or honey should be given late in the day As soon as robbing begins manipulation of colonies should be discontinued the hives closed and if necessary the entrances contracted as far as the weather will permit If brush is thrown in front of the entrance robbers are less likely to attempt entering At all times honey which has been removed from the hives should be kept where no bees can get at it so as not to incite robbing

FEEDING

During the spring manipulations in preparing bees for winter and at other times it may be necessary to feed bees for stimulation or to provide stores *Honey from an unknown source should never be used* for fear of introducing disease and sirup made of granulated sugar is cheapest and best for this purpose The cheaper grades of sugar or molasses should never be used for winter stores The proportion of sugar to water depends on the season and the purpose of the feeding For stimulation a proportion of one fourth to one-third sugar by volume is enough and for fall feeding especially if rather late a solution containing as much sugar as it will hold when cold is best There seems to be little advantage in boiling the sirup Tartaric acid in small quantity may be added for the purpose of changing part of the cane sugar to invert sugar thus retarding granulation The medication of sirup as a preventive or cure of brood disease is often practiced but it has not been shown that such a procedure is of any value If honey is fed it should be diluted somewhat the amount of dilution depending on the season If robbing is likely to occur feeding should be done in the evening

Numerous feeders are on the market, adapted for different purposes and methods of manipulation (Figs 14 15 16) A simple feeder can be made of a tin pan filled with excelsior or shavings (Fig 17) This is filled with sirup and placed on top of the frames in a super or hive body It is advisable to lean pieces of wood on the pan as runways for the bees and to attract them first to the sirup either by mixing in a little honey or by spilling a little sirup over the frames and sticks It may be stated positively that it does not pay financially or in any other way to feed sugar sirup to be stored in sections and sold as comb honey Of course such things have been tried but the consumption of sugar during the storing makes the cost greater than the value of pure floral honey

SPRING MANAGEMENT

The condition of a colony of bees in the early spring depends largely on care in the preceding autumn and in the method of wintering If the colony has wintered well and has a good prolific queen preferably young the chances are that it will become strong in time to store a good surplus when the honey flow comes

The bees which come through the winter reared the previous autumn are old and incapable of much work As the season opens they go out to collect the early nectar and pollen, and also care for the brood which hatches from the eggs laid by the queen The amount of brood is at first small and as the new workers emerge they assist in the brood rearing so that the extent of the brood can be gradually increased until it reaches the maximum at the beginning of the summer The old bees die off rapidly

If brood rearing does not continue late in the fall so that the colony goes into winter with a large percentage of young bees the old bees may die off in the spring faster than they are replaced by the emerging brood This is known as spring dwindling A remedy for this may be applied by feeding if necessary the autumn before or keeping up brood rearing by some other means as late as possible

If spring dwindling begins however it can be diminished somewhat by keeping the colony warm and by stimulative feeding so that all the energy of the old bees may be put to the best advantage in rearing brood to replace those dying off The size of the brood chamber can also be reduced to conserve heat

It sometimes happens that when a hive is examined in the spring the hive body and combs are spotted with brownish yellow excrement This is an evidence of what is commonly called dysentery The cause of this trouble is long-continued confinement with a poor quality of honey for food Honey dew honey and some of the inferior floral honeys contain a relatively large percentage of material which bees cannot digest and if they are not able to fly for some time the intestines become clogged with fæcal matter and a diseased condition results Bees never normally deposit their fæces in the hive The obvious preventive for this is to provide the colony with good honey or sugar sirup the previous fall Dysentery frequently entirely destroys colonies but if the bees can pull through until warm days permit a cleansing flight they recover promptly

Bees should not be handled in the early spring any more than necessary for to open a hive in cool weather wastes heat and may even kill the brood by chilling The hive should be kept as warm as possible in early spring as an aid to brood rearing It is a good practice to wrap hives in black tar paper in the spring not only that it may aid in conserving the heat of the colony but in holding the sun s heat rays as a help to the warmth of the hive This wrapping should be put on as soon as an early examination has shown the colony to be in good condition and there need be no hurry in taking it off A black wrapping during the winter is not desirable as it might induce brood rearing too early and waste the strength of the bees

As a further stimulus to brood rearing many bee keepers practice stimulative feeding of sugar sirup in early spring This produces the same effect as a light honey flow does and the results are good Others prefer to give the bees such a large supply of stores in the fall that when spring comes they will have an abundance for brood rearing and it will not be necessary to disturb them in cool weather Both ideas are good but judicious stimulative feeding usually more than pays for the labor Colonies should be fed late in the day so that the bees will not fly as a result of

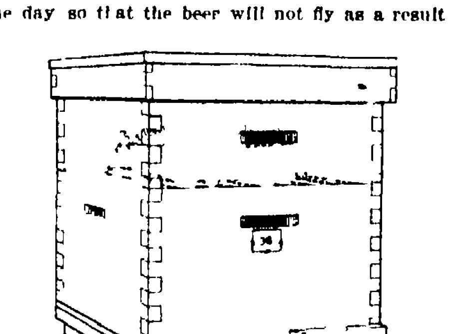


Fig 17—Pan in Super Arranged for Feeding

this and so that robbing will not be started When the weather is warmer and more settled the brood cluster may be artificially enlarged by spreading the frames so as to insert an empty comb in the middle The bees will attempt to cover all the brood that they already had and the queen will at once begin laying in the newly inserted comb thus making a great increase in the brood This practice is desirable when carefully done but may lead to serious results if too much new brood is produced A beginner had better leave the quantity of brood to the bees

It is desirable early in the season before any preparations are made for swarming to go through the apiary and clip one wing of each queen so that if a swarm issues the queen cannot fly and the bees can be easily returned to the old stand This should be done before the hive becomes too populous It is perhaps best to clip queens as they are introduced but some colonies may rear new ones without the knowledge of

the owner and a spring examination will insure no escaping swarms.

Queens sometimes die during the winter and early spring and since there is no brood from which the bees can replace them, the queenless colonies are hopelessly queenless Such colonies are usually restless and are not active in pollen gathering If on opening a colony it is found to be without a queen and reduced in numbers it should be united with another colony by smoking both vigorously and caging the queen in the queen right colony for a day or two to prevent her being killed A frame or two of brood may be added to a queenless colony not only to increase its strength but to provide young brood from which they can rear a queen Bee keepers in the North can frequently buy queens from southern breeders early in the spring and naturally this is better than leaving the colony without a queen until the bees can rear one as it is important that there be no stoppage in brood rearing at this season

SWARM MANAGEMENT AND INCREASE

The excessive rearing of brood at the wrong season or increase in the number of colonies greatly reduces the surplus honey crop by consumption The ideal to which all progressive bee keepers work when operating simply for honey is to stimulate brood rearing to prepare bees for gathering to retard breeding when it is less desirable and to prevent swarming Formerly the measure of success in bee keeping was the amount of increase by swarming but this is now recognized as being quite the contrary of success

The stimulation of brood rearing in the spring however makes it more likely that swarming will occur so that the operator must counteract that tendency This is especially true in comb-honey production Very few succeed in entirely preventing swarming but by various methods the situation can be largely controlled

When a swarm issues it usually first settles on a limb of a tree or bush near the apiary It was formerly common to make a noise by beating pans or ringing bells in the belief that this causes the swarm to settle There is no foundation for such action on the part of the bee keeper If the bees light on a small limb that can be spared it may simply be sawed off and the bees carried to the hive and thrown on a sheet or hive cover in front of the entrance If the limb cannot be cut, the swarm can be shaken off into a box or basket on a pole and hived If the bees light on the trunk of a tree or in some inaccessible place they can first be attracted away by a comb preferably containing unsealed brood In these manipulations it is not necessary to get all the bees but if the queen is not with those which are put in the hive the bees will go into the air again and join the cluster

If a queen is clipped as recommended under Spring management the swarm will issue just the same but the queen not being able to fly will simply wander about on the ground in front of the hive where she can be caught and caged The parent colony can then be removed to a new stand and a new hive put in its place The bees will soon return and the queen can be freed among them as they enter The field bees on returning will enter the new hive with the swarm thus decreasing still more the parent colony and making a second swarm less probable. To make sure of this however all queen cells except one good one can be removed soon after the swarm issues. To hold a swarm it is desirable to put one frame containing unsealed brood in the new hive The other frames may contain full sheets or starters of foundation or drawn combs Usually comb-honey supers or surplus bodies for extracting frames will have been put on before swarming occurs These are given to the swarm on the old stand and separated from the brood chamber by queen-excluding perforated zinc

When clipping the queen's wing is not practised swarms may be prevented from leaving by the use of queen traps of perforated zinc (Fig 6) These allow the workers to pass out, but not drones or queens which on leaving the entrance, pass up to an upper compartment from which they cannot return These are also used for keeping undesirable drones from escaping and the drones die of starvation When a swarm issues from a hive provided with a queen trap the queen goes to the upper compartment and remains there until released by the bee keeper The workers soon return to the hive When the operator discovers the queen outside the colony may be artificially swarmed to prevent another attempt at natural swarming A queen trap should not be kept on the hive all the time for fear the old queen may be superseded and the young queen prevented from flying out to mate

ARTIFICIAL SWARMING

If increase is desired it is better to practice some method of artificial swarming and to forestall natural swarming rather than be compelled to await the whims of the colonies The situation should be under the control of the bee keeper as much as possible The bees combs and brood may be divided into two nearly equal parts and a queen provided for the queenless portion or small colonies called nuclei may be made from the parent colony so reducing its strength that swarming is not attempted These plans are not as satisfactory as shaken swarms since divided colonies lack the vigor of swarms

A good method of artificially swarming a colony is to shake most of the bees from the combs into a new hive on the old stand with starters (narrow strips) of foundation The hive containing the brood with some bees still adhering is then moved to a new location If receptacles for surplus honey have been put on previously as they generally should be they should now be put over the artificial swarm separated from the brood compartment by perforated zinc

This method of artificially swarming (usually called by bee keepers shook swarming) should not be practiced too early since natural swarming may take place later The colony should first have begun its preparations for swarming The method is particularly useful in comb-honey production The bees may be prevented from leaving the hive by the use of a drone trap (Fig 6) or by putting in one frame containing unsealed brood Some bee keepers prefer using full sheets of foundation or even drawn combs for the artificial swarm but narrow strips of foundation have some advantages By using narrow strips the queen has no cells in which to lay eggs for a time, thus reducing brood rearing but since by the time artificial swarming is practised the profitable brood rearing is over, this is no loss but rather [illegible] also in the brood compartment so [illegible] gathering workers can deposit fr[illegible] consequently put it above in the [illegible] the combs below are built out and [illegible] creased. Late the colony is allowed to put honey in the brood combs for its winter supply. If no increase is desired, the bees which emerge from the removed brood combs may later be united with the original swarm and by that time there will usually be little danger of natural swarming

PREVENTION OF SWARMING.

Unless increase is particularly desired, both natural and artificial swarming should be [illegible] as far as possible so that the energy of the bees will go into the gathering of honey [illegible] overheated hives are particularly [illegible] ing this tendency may be largely [illegible] by giving plenty of ventilation and additional room in the hive. Shade is also a good preventive of swarming. [illegible] space in the hive may be furnished by adding more hive bodies and frames or by frequent extracting so that there may be plenty of room for brood rearing and storage at all times. These [illegible] are, of course particularly applicable to extracted-honey production

To curb the swarming impulse frequent examinations of the colonies (about every week or ten days during the swarming season) for the purpose of cutting out queen cells is a help, but this requires considerable work and since some cells may be overlooked and particularly since it frequently fails in spite of the greatest care, it is not usually practised Requeening with young queens early in the season when possible generally prevents swarming.

Swarming is largely due to crowded brood chambers, and since eggs laid immediately before and during the honey flow do not produce gatherers, several methods have been tried of reducing the brood. The queen may either be entirely removed or be caged in the hive to prevent her from laying. In either event the bees will usually build queen cells to replace her, and these must be kept cut out These plans would answer the purpose very well were it not for the fact that queenless colonies often do not work vigorously Under most circumstances these methods cannot be recommended A better method is to remove brood about swarming time and thus reduce the amount. There are generally colonies in the apiary to which frames of brood can be given to advantage.

In addition to these methods various non-swarming devices have been invented and later a non-swarming hive so constructed that there is no opportunity for bees to form a dense cluster The breeding of bees by selecting colonies with less tendency to swarm has been suggested but nothing has been accomplished along that line

On the whole the best methods are the giving of plenty of room shade ventilation to colonies run for extracted honey and ventilation shade and artificial swarming of colonies run for comb honey Frequent requeening (about once in two years) is desirable for other reasons and requeening before swarming time helps in the solution of that difficulty

(To be continued)

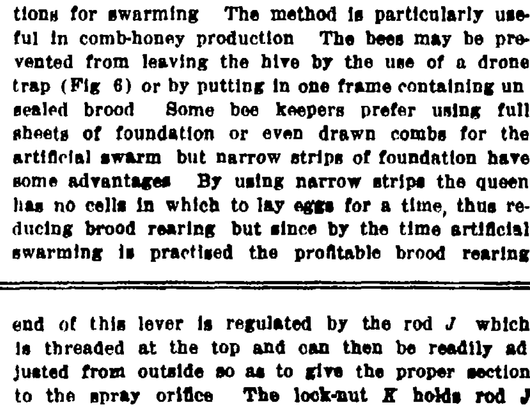
A Variable-Speed Carbureter

By the Paris Correspondent of the SCIENTIFIC AMERICAN

The extent to which the automobile has come into use for cab service in large cities has given rise to a somewhat difficult problem in carbureter design Vehicles of this kind are necessarily driven at low speed over a considerable portion of their travel owing to the congestion of city traffic Now, ordinarily a carburetor designed for normal speeds will not function satisfactorily and economically at low speeds

One solution of the problem is to provide a double carbureter which in one setting is adapted for high speed work and in another setting gives good economy at low speed Such is the new Longuemare carbureter recently tested in the laboratories of the Paris Automobile Club and described by M G Lumet chief engineer of that laboratory

The device is shown in section in our illustration It consists of the usual float-feed chamber attached to the carbureter proper From the feed chamber the gasoline passes into a cylindrical tube B through a series of holes in a stopper L fitted into the lower end of the tube Fixed on the stopper is a rod G terminating above in a point At the upper part of the tube there is a second set of holes M by which the gasoline reaches the spray nozzle F This latter is a small piece screwed on to its seat and receives the pointed end of the rod forming a needle valve controlling the spray orifice The stopper L has a sliding fit in the tube and is normally pushed down by the spring H against the action of the horizontal lever, engaging the lower extremity of L. The other end of this lever is regulated by the rod J which is threaded at the top and can then be readily adjusted from outside so as to give the proper section to the spray orifice The lock-nut K holds rod J in position If desired the nut can have ratchet



Section Through Two-speed Carbureter

teeth cut in it, so as to fix the screw in a certain number of definite positions, and this will give corresponding standard sections for the spray

The air enters at the base of the carbureter through openings N, arranged around the cylinder From the lower part it mounts through the narrowed portion P so that it passes by the spray orifice at the maximum speed. The usual carbureting action takes place and the air and gas mixture passes by D to the motor The portion D acts as valve, and can be turned by an outside handle in the manner of a gas cock, when it is desired to set the carbureter for low speed As above described, the carbureter is designed to work under normal conditions of speed The second part of the carbureter comes into use for the slow motor speed as well as for starting the automobile By turning the key D from right to left the orifice is gradually cut down and finally reduced to zero and the gas is now cut off from the motor. But at this moment a notch Q, in the key comes to the bottom and uncovers another passage leading from the carbureter to the motor, as will be seen on the left of the drawing The sections for the screw passage are calculated to suit the conditions of slow motor speed A nozzle O lies just opposite the spray orifice its distance from the spray being controlled by a screw adjustment and arranged to suit the conditions of slow running as nearly as possible This adjustment means is further supplemented by working the joint valve P so as to cut off the gas inlet more or less. The carbureter is heated by hot water jacket R fed from the pipe S

The carbureter here described is built for two settings. Evidently the same general principle could be applied to design an apparatus giving a greater number of graded settings

Preservation of Drawings (in pencil and India ink).—They should be coated with collodion (photographic), after 2 per cent of stearine has been added to it. The drawing is laid on a sheet of glass or a board, and the collodion poured over it. After 10 to 20 minutes, the drawing is dry and perfectly white.

[illegible] OF INVENTIONS

[illegible] Patent of the [illegible] were Issued for the Week Ending [illegible] 14, 1911

AND EACH BEARING THAT DATE

[illegible] note at end of list about copies of these patents]

[illegible] S. W. Stewart 984,311
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Canadian patents may [illegible] inventors for any of th[illegible] foregoing list For ter[illegible] address Munn & Co [illegible] York.

The Relation of Light to the Production of Sugar in Beets

There has been found a great deal of variation in the sugar yield of certain high grade strains of sugar beets when grown in different localities The variations were such as could not be accounted for by the differences in the soil in methods of cultivation or in fertilizers During the past two seasons (1909 1910) experiments were conducted in Utah to determine to what extent the differences in the amount of light were responsible for the differences in the amount of sugar

A long row of beets planted under the usual field conditions was selected A portion of this row was shaded with white bunting another portion with two thicknesses of bunting a third with three thicknesses and the remainder of the row left open to the full light Of course the shading resulted also in a cutting off of the heat rays from the sun so that it is impossible to attribute all of the differences found to a reduction in the light but the temperature differences were very slight compared to the light differences

The relative light intensities based on the actual duration of bright sunshine and diffused daylight throughout the entire season ranged from 100 for the open portion of the row to about 10 for the part most shaded the temperature range was from 112 deg F in the open row in full sunshine to 94 deg F in the most shaded part The beets ranged in weight from an average of 27¾ oz to 1¾ oz and the sugar content varied from 18 oz to 0 1 oz—that is in the full light there was produced more than twenty five times as much sugar as in the most shaded region

It appears also that not only is the actual amount of sugar affected by the amount of light, but even the purity of the juice this ranged from 76 7 per cent at one end to 61 per cent in the most shaded portion Not only then would the farmer get a better yield from growing the beets in fields or localities with a maximum of light exposure but the beets raised under such conditions could be more economically utilized at the sugar mill

Moire Decoration on Sheet Tin.—a Carefully warm evenly tinned sheet iron (sheet tin) until the tin coating is just melting (to about 536 deg) and quickly throw it into the following mixture 2 parts chloride of tin in 4 parts water 1 part commercial nitric acid and 2 parts hydrochloric acid After drying coat, if desired with shellac solution tinted with aniline color b If a piece of tin be heated in one place by contact with a hot soldering iron as over the flame of a light, the tinning within a circular space will be melted and after cooling and etching with hydrochloric acid will display a fairly regular radial star shaped figure If we pass over the sheet tin with the soldering iron or the flame in a line grain-ear shaped strips will result and by this means garlands names and ornaments can be produced on the tin If it is desired to cover a sheet uniformly with crystals it should be evenly heated over a coal fire until the tin begins to melt If water is then thrown on it, in a fine spray each drop of water falling on it will form a center of crystallization If the water is caused to flow by inclining the plate a striped or veined pattern will result If the heated plate is immersed in an inclined direction in cold water a fine moiré of granite-like design will be produced. After [illegible] it [illegible] be etched by waxing in dilute hydroch[illegible] to [illegible] some nitric acid has been added [illegible] then to be washed with clean water [illegible] some caustic potash, to remove an[illegible] that may have formed and finally agai[illegible] with clean water Finally the moiré is co[illegible] with a transparent varnish

Considerable interest in being [illegible] in Norway and Sweden as regards the m[illegible] of steel by the electric furnace process. T[illegible] daily papers state that one of the lea[illegible] of the Great Swedish Copper Company [illegible] has been engaged in the construction [illegible] electric steel furnace on the Grönwall type wh[illegible] designed for 4 000 horse-power and he expects [illegible] operating it in the near future Owing to the [illegible] position which he occupies among iron m[illegible] the announcement caused somewhat of a stir However, other steel furnaces are erecting in the Sc[illegible] region. The Swedish syndicate of iron man[illegible] known as Elsenkontor is building a 2 500 horse-power electric steel furnace of the same type It is located at the Trolhattan fall near the great hy[illegible] plant The sum of 250 000 crowns has been [illegible] for testing the adaptability of various kinds of [illegible] ores for the process. Matters are also active in Norway and by next spring it is expected to have the electric iron and steel plant in operation on the Hardangar [illegible] has an output of about 4 000 horse-power Two of the leading Russian iron works are taking up the question of electric steel manufacture and they have purchased the rights for the Heroult [illegible] pro-cess One of these firms is the Sormovo Iron Works and the other the Makievka Blast Furnaces and Steel Works in the Donetz basin

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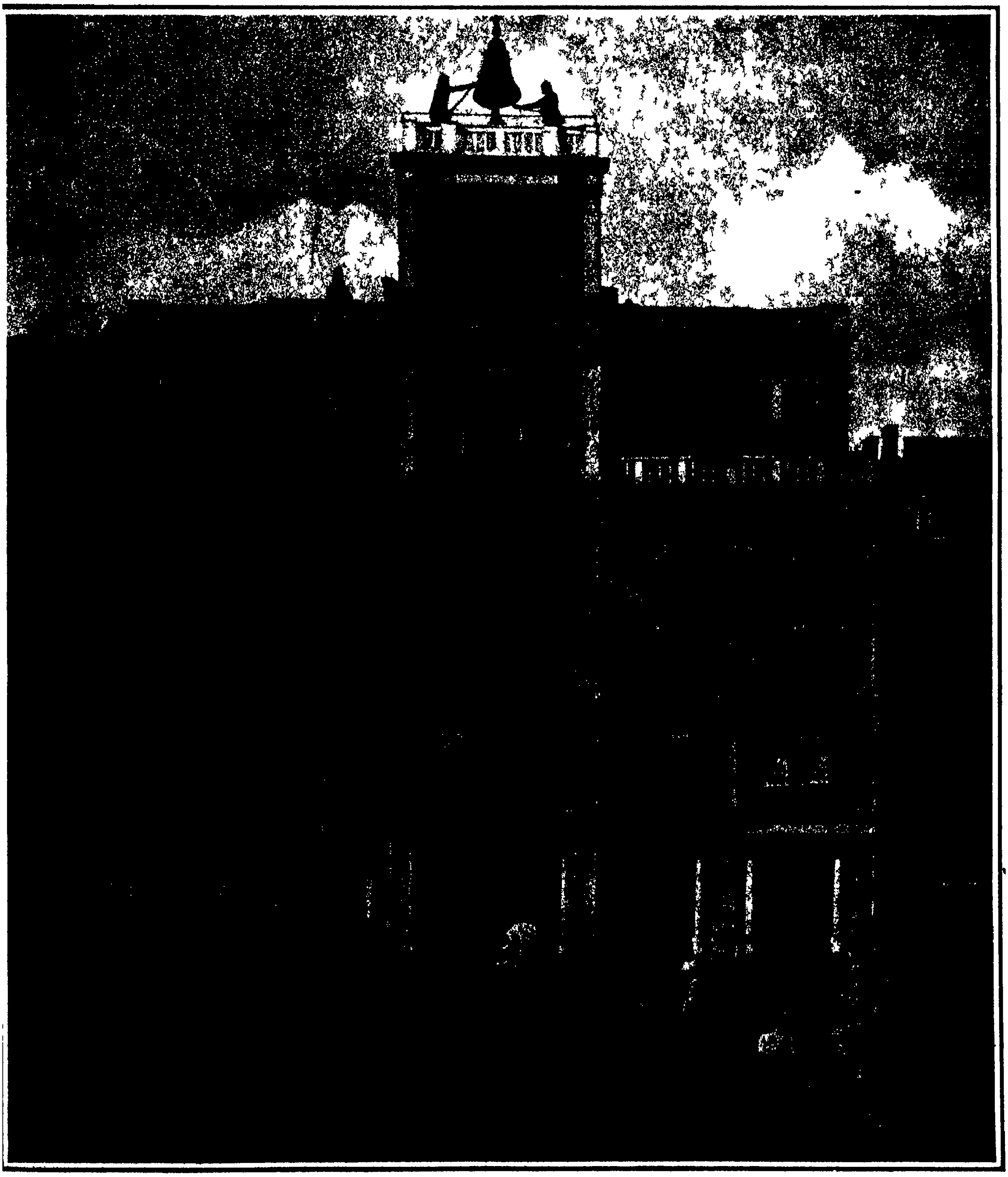

THE CLOCK TOWER AT VENICE SHOWING THE BRONZE MOORS AND BELL; THE WINGED LION OF ST MARK'S; THE VIRGIN AND INFANT AND THE GREAT DIAL

THE FAMOUS ASTRONOMICAL CLOCK OF VENICE—[See page 136]

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Selection and Treatment of Alloy Steels for Automobiles

Why You Can Buy a Good Car for Little Money

By Henry Souther

A PECULIAR remark during the last few years has been to the effect that the steel business has advanced and changed rapidly and that the incentive is found in the manufacture of automobiles This condition still continues and the evolution within the construction of the car itself is no less rapid Design materials style and selling methods are all involved

Curiously enough it would seem at first glance that the choice of materials is involved in all of these four branches of the industry and not in the one or two as would seem natural

The reasonable use of materials is to be the theme of this paper Many considerations are involved in looking back to the beginning of the automobile industry and it seems necessary to do this in order that the evolution may be followed as far as materials are concerned

At the beginning every faculty of designer and builder was focused on the production of an operative machine Materials were disregarded so long as they would help build the vehicle and were obviously steel brass aluminum or wood All were too busy to regard the quality Generally speaking there were available from the stand point of the automobile builder Bessemer steel, open hearth steel and cast or crucible steel Variations within these classes were regarded as unimportant and heat treatment was an unknown term Certainly only theoretical at the best and therefore useless to a practical man

Now these same men have among them those who state that the heat treating department of the works is the most important of all This is not so with all yet; there are some who still balk at talk of critical points, recalescence pyrometers and the like The evolution is rapid however and this class will soon disappear

After a year or two the cars operated very well; at least well enough to run long enough to break parts crank shafts axles and steering parts Then a little attention was directed toward steel There seemed to be no clear idea of a cure If a steel part broke with an appearance of brittleness good old wrought iron was tried as a sure cure If bending occurred tool steel was tried in some cases and medium carbons (0 50 per cent) in others it being understood that high carbons were stronger but brittle The natural or annealed state was the only one known to the automobile industry at this time

At about this time nickel steel was mentioned as a possibility It had been used or as some said advertised as used for bicycle construction But generally it was regarded as something fancy and not worthy of the consideration of hard headed men It was expensive hard to work and no good anyway in the opinion of many

So when alloys came along in earnest and were offered systematically by steel agents they had a hard time making any progress The high prices quoted were laughed at There seemed to be no chance that alloys would ever be given a fair trial After some little time and persistence by the steel agent alloy steels were tried and proven good even at 15 cents per pound Some designs required alloy steels to stop breakage the result of small dimensions sharp corners where fillets should be and similar mistakes In this way the alloy or perhaps the high quality carbon steel had a chance to make good in a spectacular way These instances helped the spread of high grade steels until now the pendulum has swung too far and alloys are used where they need not be and money is thereby wasted There is indication of a notion that an alloy steel is a cure all and that if needed in one part that it must be a fine thing in all parts

Unfortunately the art of heat treatment has not spread as fast as alloy steels have and many cases exist where very expensive steels have been put into cars in an annealed or forged condition; which is absolutely unreasonable The alloy steel is no cure all and must be used intelligently if any compensation for increased cost is to be realized

A case in point is found in an engine crank shaft It is large for the duty If it is made of an alloy treated up to 100 000 lbs per sq inch or more when 60 000 lbs. would suffice there has been no gain to the automobile and there has been a money waste It is not generally understood that a high elastic limit adds nothing to the stiffness or rigidity of a part It does add to resistance to fatigue but with the case in point the shaft is over size and fatigue cannot take place in the absence of bending

The same general condition applies to gears of all kinds It is not the rule, by any means, that gears of smallest section are made of the strongest steels. This should be so and is so in one very marked case On the other hand many very heavy gear sets, duty considered contain steel of greatest strength and all out of proportion to necessity This is unreasonable as it is obvious that strength should be a function of design. A bridge or a building is calculated to a nicety as yet automobiles rarely are Knowledge of steel is not yet sufficiently wide-spread The history of the automobile is short and there has not been time enough to disseminate knowledge of so many special steels and special treatment Then too an air of mystery regarding special steels and secret treatments has been fostered in some circles in such a way as to befog the issue and retard the spread of truth.

This paper treats of the various kinds of alloy steels and their applications in the automobile industry Attention is called to the necessity of selecting steels which will do most efficiently the particular work for which they are intended.

At the beginning of the automobile art the steel industry was old Alloys and heat treatments were no mysteries to the steel metallurgist Makers of armor plate gun tubes propeller shafts and other important specialties had been using many grades of steel and many treatments to meet peculiar needs. This knowledge had not and does not spread readily to makers of small arms sewing machines, bicycles or typewriters and they all need it to some extent

Some reason for this is found in the "old fashioned" selling methods of many steel companies Most salesmen are not furnished with accurate knowledge of the steels they sell or if they are they are forbidden to use such knowledge on possible customers They use a line of argument that contains no metallurgical information and is too often far from the truth There are large numbers constantly engaged in this way so it is no wonder that little real progress is made by aid of the salesman Fancy names and fancy prices for common steel is their specialty

It is a pleasure to feel that such methods are giving way to others and better The steel works engineer metallurgist or chemist is now placed in contact with the consumer His wants are learned and supplied without secrecy or mystery The opportunities of change and improvement are pointed out and advance in the art will be rapid As it is now there is but little knowledge among consumers as to the relative importance of analysis and heat treatment or of the importance of casting rolling hammering and cold working of steels Consequently many consumers are in doubt as to what to believe the truth as expounded by the conservative metallurgist or the near truths about the special alloys of the salesman

Before taking up the finer steels it is well to study the history of what preceded them in the automobile art

At the outset carbon steels were mostly considered and known as machine steel Such steel was available and cheap or at least low in first cost Such steel is not always cheap as much of it tends in machining to such an extent that work is ruined or will not permit the cutting of a thread at all because of its softness Such machine steel is of about the following composition It is not strictly speaking machine steel but there is so much of it on the market so called, that it must be recognized Carbon 0 08 to 0 13 per cent phosphorus 0 08 to 0 10 per cent manganese 0 40 to 0 60 per cent and sulphur 0 06 to 0 08 per cent

Machine steel, so called as found in steel warehouses is not all alike by any means This lack of uniformity is discovered by the user whose judgment usually is that the steel is no good anyway and does not behave twice alike in the machine shop

The best machine steel then existing in stock was of about the following composition with carbon from 0 18 to 0 25 per cent with other elements like the foregoing analysis Such steel machines smoothly and cuts a keen thread A slight increase in carbon coupled with the other elements given makes a very marked difference in machining quality A third quality of machine steel found on the market at the time in question was between the other two in carbon contents and much higher in manganese analyzing about as follows: carbon 0 12 to 0 18 per cent phosphorus and sulphur about 0 08 per cent and manganese from 0 60 to 0 90 per cent The manganese contents made for smooth cutting and the steel was a good one for carriage axles which must be machined very rapidly and other similar uses

These machine steels were all characteristic of Bessemer output and were put into the early automobiles They answered the purpose until the machines began to wear fairly well and poor (weak) design developed High carbons were tried and wrought iron was tried all in a blind unreasoning way Some troubles were cured but some could not be cured by any change of material known at the time The details of design were such as to cause failure with any material Failure was delayed but not prevented

One grade of steel common then and now, known as screw stock deserves notice as it plays a more important part in automobile construction that it ought to It is close to machine steel and is sometimes sold as such. The approximate analysis is as follows: carbon 0 08 to 0 12 per cent., phosphorus 0 12 to 0 18 per cent., manganese about 0.50 per cent, sulphur about 0 10 per cent The dominant element that makes for easy cutting is phosphorus, which is twice normal for Bessemer steel. More steel of this quality than of any other composition, can be put through an automatic screw machine in a given time, and turn out a fine product. But the drawback is phosphorus, which causes brittleness in steel and makes it unsafe for automobile construction. Except in screws of no importance or parts carrying no load, it should not be used. Important screws are now made of alloy steels heat-treated. Connecting-rod and engine-base screws for example The above screw stock after casehardening, as it often is, shows a coarse brittle grain even with the best of treatment No hardened parts of this quality should be used.

At the present time little steel high in phosphorus finds its way into automobile construction Basic Open Hearth steel is mostly used and this is uniformly below 0 04 per cent in both phosphorus and sulphur

This quality of steel in the vicinity of 0 10 per cent carbon machines with the greatest difficulty, consequently a standard machine steel has been developed containing enough carbon and manganese to offset the softness. The analysis is as follows: carbon 0 20 to 0.30 per cent., phosphorus and sulphur not over 0 04 per cent., manganese 0 40 to 0 70 per cent

This quality of machine steel handles well in every stage of manufacture and responds to heat treatment in a way that makes the product suitable for many parts of a car This steel is a fine steel for general run of drop forgings It is suited for the important members of low priced light cars and for carbonized and hardened bevel and transmission gears in such cars as are of low power and generous gear design

With the general use of basic open hearth steel this type of machine steel is bound to be generally adopted Its usefulness is very wide spread and its cost as low as any open hearth steel The extra expense that is warranted is the care necessary to free from seams or other physical defects This is done by the steel maker or the one who prepares the billets or bars for shipment. Freedom from seams insures a sound product at the finish of an expensive series of operations and is worth paying for

Simple heat treatment will give an elastic limit per sq inch of 60 000 lbs This is the result of quenching at about 1,500 deg F in oil, then partially annealing at 800 deg or 900 deg F Such strength is accompanied by good refinement of grain and corresponding toughness and capacity to resist shock and repeated alternate stress The machine steels previously mentioned would not be safe under the foregoing treatment or any other; as refinement of grain does not take place to a satisfactory extent in the presence of so large a percentage of impurities

Without a fine grain development in steel fatigue takes place very rapidly In using this term "fatigue" the same phenomenon is in mind that is often referred to as crystallization Cold crystallization does not take place It is a different physical change and will be discussed later

About the years 1893-1894 bicycle parts often failed (to quote) while riding along the smoothest road The fractures did not exhibit coarse crystals as a rule particularly in cold drawn spoke wire or tubing But in every case there did exist an opportunity for concentration of strains bending or vibration at a limited section These failures led to studies of fatigue conditions

It was commonly thought by well trained mechanics that the softest toughest steels would resist longest under these conditions simply because of the tough quality This was found to be not so Tough and soft steel is weak steel having an elastic limit per sq inch from 30 000 to 40 000 lbs A good grade of 0 40 per cent carbon steel may have an elastic limit of 50 000 or 60 000 lbs Such steels in an annealed condition were compared under such circumstances as to produce a fatigue break The dead or actual load used in comparison was the same This load was chosen to produce a fiber stress nearly as great as the elastic limit of the weaker steel say 25 000 lbs per sq inch (about 84 per cent) This stress was only 50 per cent of the elastic limit of the stronger steel The weaker steel soft and tough, broke quickly after 20 000 to 50 000 alternations of stress The stronger steel looked upon as being brittle and hard endured say 400,000 alternations of stress, an increase not in direct proportion to strength and quite contrary to the characteristic of toughness as measured by elongation It is evident that the toughness was not the controlling element under fatigue conditions and that strength as indicated by elastic limit was an important factor with some other element not obvious, playing an important role Such an element was sought in the crystalline structure Such structure is fairly indicated by transverse fracture for the purpose in hand The fracture of the low-carbon tough steel is coarse grained with crystals presenting large cleavage planes. That of the higher carbon, brittle steel, showed a close grained structure with no crystals having cleavage planes of conspicuous size. That is, the steel that endured longer was strong and fine grained These were the controlling elements.

It is for this object that all heat treating processes are practised—to produce greater strength and to refine the grain The most reasonable steel to use in automobiles is that which will respond best to treatment or that will respond sufficiently for a given purpose, dimensions and duty considered There is no reason in selecting a steel that will not respond somewhere in proportion to the cost of the operation; that is, the improvement must be material. Neither is it reasonable to select a steel at great cost that will respond to such an extent as to be way beyond the necessities of the case.

The treatment necessary to give a steel depends some-

what upon the physical condition of the steel as received by the consumer or user For example, it is quite possible and often happens that bars of steel reach the manufacturer of automobile parts in a very coarsely crystallized state, this being due to the last forging or hammering operation prior to shipment by the steel mill. If this steel is to be used by the parts maker without further drop forging or other heating operations, the steel must receive a thorough annealing In the absence of such annealing operation, which will reduce the coarse condition of it to a properly refined condition, a single heat treatment will not produce the expected results

If, on the other hand, the bar or billet is to be forged, then this coarse crystalline condition matters but little and the annealing must necessarily follow the forging operation and for the same reason, to guard against a possible condition of coarse crystallization which will not be refined by a single heat treatment

Our steel makers would do well to learn whether or not the consumer of the steel is to again forge. If not, annealing should be the final operation at the steel works in all cases Otherwise, steel of good quality may not perform as well as it should

It is not always possible for the steel manufacturer to know whether or not steel is to be forged again and, in view of that fact, it is the habitual practice of some of the steel mills to anneal as a final operation No harm is done if the steel is again forged, and if not forged the steel is found, by the user, to be uniform in machining qualities and well behaved under heat treatment Uniformity of machining quality is of far more importance in the eyes of the mechanic than is fully appreciated by many steel companies Many thoroughly good qualities and shipments of steels are complained of and perhaps condemned because of the presence of so called hard spots and bad cutting qualities The machine shop cannot be expected to know that it is not the composition of the steel that is at fault and the steel maker should guard against such complaints by the relatively inexpensive operation of annealing

These remarks apply very strongly to tool steels that are to be shaped into expensive tools, to spring steels and to the higher carbon steels in general They apply in a lesser degree to the lower carbon steels but nevertheless are of great importance

Many machine steels are condemned because tools are rapidly dulled in machining them and the complaint is as a rule that they are too hard to cut As a matter of fact they are too soft to cut smoothly They tear and cling to the point or edge of a tool and the cutting operation becomes more or less of a rubbing operation which creates heat and dulls the tool by softening it Proper annealing suited to the carbon will correct this fault, but the machine shop manager cannot be expected to know this and probably has no facilities for annealing or other heat treatments in many cases

Take an engine crank for example Other considerations than strength influence the design It must have ample diameter to furnish adequate bearing surfaces It must be rigid and stiff No alloy can increase this latter quality A steel with 60 000 lbs elastic limit per sq inch is quite strong enough to outlast the engine One of 200 000 lbs elastic limit would make no better crank shaft under the assumed conditions and would cost more at first cost in forge in machine shop and in heat treatment This is a fair example of unreasonable use of alloy steel

To return to qualities producing endurance under alternate stress A drop forging as it comes from the dies is likely to be in a non homogeneous condition as the result of the process and at the best, because finished at a relatively high temperature is likely to possess a very coarse open grain If intended for a vital part this grain must be refined It may be perfectly done by proper heat treatment and it is done habitually by careful operators The result is a homogeneous piece of metal No other character of steel is fit to enter the construction of an automobile where it is potentially possible of much harm or much good Carbon steels should be so treated alloy steels must be if fair value for money spent is to be received

Alloy steels of expensive variety have been put into cars without heat treatment just to say that they were used An alloy steel not suitably treated, that is in an annealed or forged state, is little if any better than good open hearth machine steel in an annealed condition Its endurance under fatigue test is low Its elastic limit is low, and its structure as indicated by transverse fracture is bad Such use of alloy steel is unreasonable and the only additional value obtained for the excess paid as compared with carbon steel is an advertising value.

On the other hand alloy steels suitably chosen and heat treated have extricated many an engineer from real trouble A driving shaft, having 60,000 lbs elastic limit, for example, may have proven weak with good carbon steel Because of the design of connecting parts a change in dimensions is often practically impossible. A solution is easy with a good 0 30 carbon, 3 5 per cent nickel steel treated to 90,000 lbs. per sq inch elastic limit, or if necessary a chrome-nickel of high carbon treated to 150,000 lbs. elastic limit Such applications of alloys are worth all they cost and are reasonable in every way

It is the alloy steel that responds best of all steels to heat treatment. Results are obtainable that are nothing short of wonderful. Only recently a tensile strength of 300,000 lbs. per sq. inch has been reached. Coupled with such strength, say 300,000 lbs. per sq. inch, very great ductility is obtainable as indicated by elongation and reduction of area at section of rupture Too great stress cannot be laid on this last item It is the best measure, in a tensile test, of the degree of refinement of grain attained by heat treatment. Reduction of area will be slight if the crystals or grains are large If the grains are large as already stated, endurance under fatigue will be little and endurance is beyond argument the most valuable asset of an automobile subject as it is to *shock and vibration at all times, while in motion*, and to an extent beyond any other mechanism

Attention has been called to the relative endurance of 0 10 and 0 40 per cent carbon steels under fatigue test Under the same dead load a specimen of 0 30 per cent carbon, 3 5 per cent nickel heat treated will endure several million alternations of a 25,000 lbs per sq inch fiber stress, and a specimen of 7.5 per cent nickel has endured one hundred million without rupture with the fiber stress at about 30 000 lbs per sq inch The tensile tests give no indication of any such difference in endurance unless it be in the reduction of area coupled with a high elastic limit These figures are always large with good endurance The reduction of area is a measure of fine grain, so it would seem that this quality may be the most influential in determining endurance

There is a good chance for theorizing and reasoning along this line With the theory of cold crystallization set aside, a reasonable cause for breakage must be found Steel may be considered as made up of crystals *which interlace and adhere* If a test specimen were made up of crystals whose faces equalled the diameter of the specimen, there would be the exaggerated condition of all adhesion and no interlacing One cleavage plane extending across the specimen It is easy to conceive that the separation of surfaces once started would jump at once across the specimen and rupture would occur There would be only adhesion to overcome It is equally plain that were the same specimens made up of an infinite number of crystals, that a separation started at the periphery would meet with an interruption before being of finite size after which a fresh start might recur at another point to meet with similar interruption In this way an infinite number of starts would be necessary to bring about rupture In other words there would be no chance for a continuous fracture along any one line or surface and rupture would be delayed indefinitely

A fibered piece of steel endures better than one not fibered although both may be of very fine grain It is easy to conceive that if fiber is all the name implies that an incipient fracture formed in one fiber could not continue across the space between fibers and would thus stop Wrought iron breaks under fatigue as in an axle or shaft The fracture always shows crystals Is it not possible that a fatigue break can take place only where crystals exist and that because crystals are at a given section fracture takes place there?

It is easy to understand how a progressive fracture may proceed along the faces of a series of crystals as in the splitting of granite by means of wedges driven into a row of holes It is not easy to conceive the splitting of good fibrous hickory or elm except with and along the fiber Splitting across the fiber is impossible there could be no continuous fracture and therefore no rupture

A fatigue break has been described as progressive intermolecular rupture It would seem more probable to be intercrystalline inasmuch as the molecules of a given composition are doubtless all of a size regardless of heat treatment or physical treatment On this theory heat treatment would cause no difference in behavior under fatigue which would be contrary to fact

Another phase of fatigue is that such breaks rarely if ever occur unless strains concentrate at or near one plane or section If strains be distributed as in a beam of uniform strength fatigue does not occur A generous fillet or a taper retards fatigue almost indefinitely A sharp corner causes it to occur very quickly

Design and material both play an important part and the two must be considered simultaneously if good engineering is to be attained If a design be adequate with poor material it is folly to buy better If design be suited for the best then only such may be used otherwise bending and breaking will occur at once These statements seem too simple for reiteration but it is a sad fact that both simple truths are violated in automobile construction

There is one form of heat treatment as old as the hills that is little understood by many that have practised it longest namely casehardening" It is easy to turn out coarse or fine grained product The fine grained is desirable (as in good tool steel) the coarse grain is not, as in burned tool steel Too few realize that a low grade steel after carbonizing is no longer low grade It has had money spent on it to improve it and if the low carbon was pure steel the high carbon exterior the result of carbonizing is pure high carbon steel, therefore good tool steel and must be treated accordingly

No tool dresser would heat tool steel in boxes for ten hours at a temperature of 1 700 deg F then quench in water at that temperature and expect a tool to do good work Yet this is exactly what is done in many otherwise well regulated plants, and the steel is blamed if the parts so treated are brittle. So treated the crystals are large, the steel is brittle

If used for ball or roller bearings, the polished surface is friable and crystals spawl out thus starting pits and fractures Suitable refining treatment improves this condition and makes a success out of a possible failure.

In casehardened parts two qualities of metal are to be dealt with, and the best practice demands treatment that will refine both grades The interior of two are the original carbon and the exterior a carbonised layer of a higher carbon The refining temperature of the lower carbon is higher and one treatment must reach this. The other temperature, correct for the high carbon, will not undo the refinement of the lower carbon. Thus by two treatments both qualities are fully refined and the composite structure is a good one. Alloy steels are subject to the same laws, and it is only necessary to be acquainted with the critical points of the various compositions to get the best results

Transmission gears and main drive bevel gears are successfully made of carbonized steel, both carbon and alloy The quality selected must be referred to design and duty The duty of constant mesh gears running in oil is relatively easy if the dimensions be generous The duty of clashing transmission gears is never easy and may be awful with [illegible] manipulation by the car driver and with clashing taking place under loaded or partially loaded conditions

With equally good design the bevel driving gears do not need the same or as good steel as the transmission gears It is common and good practice to make the large bevel gear of good carbon steel and the driving pinion meshing with it of an alloy steel

The character of the treatment and resulting condition of the steel is of vastly more importance than the composition of the steel used The best of alloy steel may be so handled in treating as to produce a weak and inferior part Similarly by the best of treatment good open hearth machine steel may be so well handled as to make a most excellent main drive pinion or other part

It is true that the best must be produced for a few designs but such are much in the minority at this time There has been very little real close designing as yet Empirical knowledge and data as to available materials are not yet exact The art of heat treating is not uniform and wide spread among producers of automobile parts A liberal margin of safety against uncertainty and non uniformity is still the rule

There is one practice in vogue among purchasers of alloy steels that does not seem to be founded on good reason It is that physical requirements are specified in face of the fact that the steel is to be forged and heat treated before being used in a car Its final condition may bear no relation to its purchased condition It may be carbonized for example If steel be purchased on chemical analysis, the control is sufficient With a known composition heat treatment may be intelligently directed without reference to original tension test characteristics

If to be used as purchased the matter is different and physical characteristics must be known Elastic limit reduction of area elongation and tensile strength in the order named are desirable If these physical tests be demanded then complete chemical analysis must not be The steel manufacturer cannot produce if tied hand and foot It is proper to specify chemical analysis as to impurity that is phosphorus and sulphur and also as to the dominant elements nickel chrome nickel and so on Even in these elements manufacturing tolerances must be allowed The practice of limiting all elements coupled with physical requirements is wrong and often leads to the absurd situation of specifying an impossibility

Even at the best with the one writing the specifications knowing exactly what has been the practice in one steel works it is not certain that in another works the result would be quite the same Some works use melting processes, casting methods and forging methods that may easily modify physical characteristics as compared with practices in other works

With a given quality of automobile in view the number of grades of steel necessary to construct it is few namely a good all around forging steel, a steel of slightly better quality to be used for gears a spring steel and a steel suited for the pressed sheet steel portions of it

These steels properly handled and heat treated each part for its peculiar duty will produce a car of very high grade so far as the steel portions are concerned

The car of extreme design racing or otherwise one that has been designed to strip off the last pound of weight must be handled differently Such a car is the exception and must be treated accordingly

If an order be accepted at all under such unfair restrictions it must be at an advanced price to cover probable difficulties This simple fact is so well known to the steel producer that it is apparently [illegible] it but it is not well known by the steel consumer and needs repeating for their benefit

To sum up the attempt has been made to indicate that *alloy steel is better than plain carbon steel* that is stronger and more enduring that the design of some cars is such as to necessitate the use of the strongest alloy steel and that the design of others is such that an alloy steel is superfluous and money wasted

That steel that is good for one purpose is bad for another and really that the term good steel is meaningless unless it be understood "for what" Pure steel meaning freedom from impurities, means something always It insures that such steel will give "good results if the composition is suitable for a purpose and if the steel be treated to develop proper physical characteristics for the duty to be performed Several steels (compositions) may be available that will perform a given function perfectly if properly selected and treated No consumer need be tied to one maker one composition nor one method of treatment Several of each are always at hand that will give satisfaction Reasonable use of steels can only be reached along lines as broad as this — *Journal of the Franklin Institute*

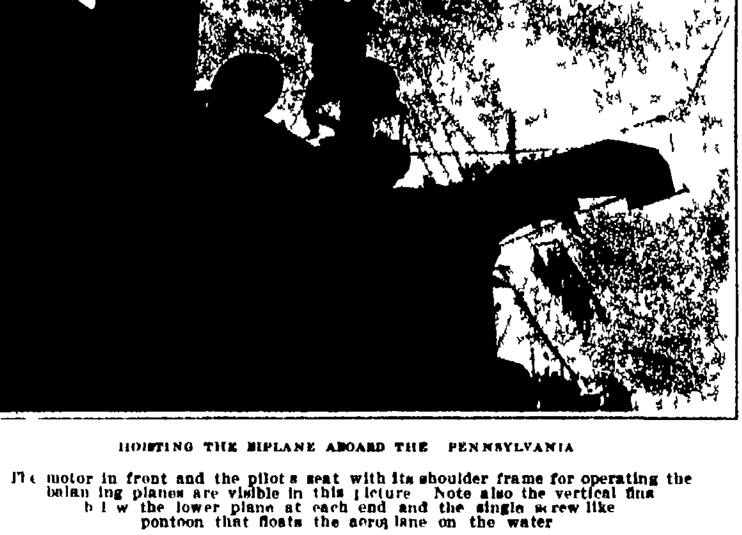
A British inventor has devised a new standard resistance unit for heavy currents It consists of a glass tube filled with mercury and fitted with platinum terminals communicating with the mercury The heat produced by a current passing through the mercury causes the latter to expand and rise in an auxiliary tube of fine bore, graduated in ohms.

Curtiss's Experiments in Rising from the Water

How the Winner of the Scientific American Trophy Developed a Satisfactory Float for His Biplane

During the past two years Glenn H Curtiss, who, *more than any other experimenter has been given to* developing the aeroplane for various uses, has experimented with floats for his biplane that would enable it to rise from the surface of the water Something over a year ago he succeeded in developing a speed of about 20 miles an hour on the water but this was insufficient to rise from the surface

At the first try-out, while traveling over the water at high speed Mr Curtiss found himself suddenly nearing the shore, and to avoid running aground he turned his horizontal rudder sharply upward, with the result that the machine rose from the water with perfect ease He soon alighted again, and in the second flight he made a circle and remained in the air a minute and 21 seconds. Two other experimental flights were made the first day, and on January 27th he made a 3½ minute flight and stated upon alighting that he found no difficulty in remaining aloft as long as he pleased The machine showed a speed of 50 miles an hour in the air as against 45 miles an hour when skimming over the surface of the water



HOISTING THE BIPLANE ABOARD THE PENNSYLVANIA

The motor in front and the pilot's seat with its shoulder frame for operating the balancing planes are visible in this picture Note also the vertical fins below the lower plane at each end and the single screw like pontoon that floats the aeroplane on the water

At the beginning of the new year Mr Curtiss moved to the Pacific Coast and set about endeavoring to develop suitable floats which would make it possible for his machine to rise from the surface of the water These experiments have been carried on at San Diego where Mr Curtiss is instructing several naval and military officers in the art of flying

In his first experiments on the Pacific Coast Mr Curtiss followed the successful experiments of this sort made by M Henri Fabre at Marseilles France about a year ago as far as the design of his floats was concerned He constructed one large float six feet wide five feet from front to rear and one foot thick at its central point, and placed this under the center of the machine The bottom of this float was perfectly flat and arranged at an incline of 10 or 12 degrees Some distance forward of the main float, at about the position of the front wheel in the land machine, another float six feet wide by one foot from front to rear and six inches deep was placed; while at the extreme front end of the machine on a special outrigger was mounted a small elevating hydroplane six feet wide by eight inches in a fore and aft direction, and one and one half inches thick. This hydroplane was fixed at an angle of about 25 degrees and was intended to lift the front part of the machine A spray shield was fitted back of it as shown in the diagram

The first experiments were made with these new floats on January 26th last; and although they made a considerable disturbance in the water especially at low speed, the aviator was enabled to get up a speed on the surface of about 45 miles an hour He found that at as low a rate as ten miles the hydroplanes (which normally were submerged) rose to the surface while as the

Not satisfied with the several floats with which he had attained his first success in rising from the water Mr Curtiss immediately constructed a single float 12 feet long by 2 feet in width and 12 inches deep This float is built of wood and resembles a flat bottomed boat or scow the top being covered with canvas to keep the water from getting in Three feet from the front end the bottom is curved upward forming a bow the full width of the float while at the same distance from the rear the float slants downward in a similar manner

This single float is placed under the aeroplane in such a position that the main weight of the machine and aviator is slightly to the rear of the center of the float which causes the latter to incline upward slightly and thus gives the necessary angle for hydroplaning on the surface of the water The weight of this new float is but 50 pounds, or less than half as much as that of the two floats that were used before

The paint was barely dry on the new float before Mr Curtiss had it fitted to his machine and gave it a trial This was done on February 1st and the trial was thoroughly successful The machine ran over the surface of the water with very much less disturbance than before and rose in the air readily A glance at the photographs showing the new and the old floats in action will give one an excellent idea of the much less commotion caused by the single scow shaped float Besides being much more compact and creating less disturbance this

the surface, even though the scow-shaped float used is but two feet in width.

After meeting with success with his new float, Mr Curtiss, on February 17th, made more flights with the motor and propeller placed at the front of his biplane and with his seat placed at the rear of the main planes. The chief of these flights was one which he made from North Island, where he is experimenting, over San Diego harbor to the cruiser "Pennsylvania." He alighted upon the surface close beside the cruiser and his aeroplane was hauled up beside the warship and placed on her deck. Two of our illustrations show the improved machine skimming the surface and Mr Curtiss landing on the cruiser In the latter picture an excellent idea of the biplane and float is obtained. The special twin V-finned tail with a vertical fin in the center, and the stabilizing fins running from the lower plane to the inclined props above mentioned, are shown distinctly in this picture, as well as the balancing planes at the rear of the main planes half way between them, and the scow shaped float beneath The reversed positions of the motor and aviator's seat is also apparent, but the greatest change is the removal of the front horizontal rudder For this reason it was possible to raise the machine so close alongside of the cruiser that the aviator could climb aboard It would seem that this new arrangement of motor and propeller and the doing away with the front rudder was very good for naval work, although Mr Curtiss himself did not like the arrangement on account of the air from the propeller striking his face and the motor and propeller interfering with his view forward

After a short visit on the cruiser the aviator was again lowered to the surface in his machine A sailor started the engine, and Mr Curtiss flew back to his starting point in short order The naval authorities were greatly pleased with his demonstration and it is probable that the Navy Department will purchase one of these machines in the near future and continue the instruction of its officers

After increasing the surface of his biplane Mr Curtiss on February 24th, took up one of his naval pupils, Lieut T G Ellyson, as a passenger He made a flight of 1½ miles, rising to a height of 100 feet and flying as slowly as 25 miles an hour or as fast as 50 miles an hour, at will Lieut. Ellyson was seated on the pontoon below the aeroplane He could look down in the water and see bottom at a depth of 25 feet, and he believes submarines can be easily located by flying over the water The slow speed at which it is possible to fly will make the biplane especially useful for bomb dropping As we go to press Mr Curtiss is about to try his machine fitted with wheels and floats as well

SKIMMING THE SURFACE AT 40 MILES AN HOUR WITH SCOW PONTOON

THE BIPLANE GATHERING HEADWAY WITH HYDROPLANE FLOATS.

The water remains nearly unruffled as the craft passes over it. Note disturbance caused by the floats compared with that caused by the scow

THE FIRST FLIGHT OF A BIPLANE FROM WATER.

speed increased only the rear edges of the two main planes were required to support the machine The aeroplane readily attained sufficient speed to rise in the air, for as the speed increased and the floats emerged from the water, the head resistance of the floats diminished and there was only the skin friction of the water on a few inches of the rear edge of these floats, plus the air resistance, to be overcome.

float or scow can be used for carrying articles or a passenger

In order to keep the aeroplane from tilting to one side or the other, an inclined stick four feet long and three inches wide, to which is attached on its upper side an inflated rubber tube, is fastened to the front edge of the lower plane at each end. By the use of these props the aeroplane does not tip readily when skimming along

Problems in Chemical Industry*

By J T Baker

[The writer discusses the difficulties which arise when an attempt is made to apply on a commercial scale the results obtained from laboratory experiments. He is of the opinion that the chemist is best fitted to overcome these difficulties who combines with the scientific mind a certain amount of common sense]

Industrial chemists may well pride themselves upon being engaged in one of the most important and useful branches of the so-called sciences of the present day, and one that requires, in a certain sense, more science in the solution of its problems, than any other

The question has often occurred to me, however, to what extent is chemistry a science and is the solution of its problems a purely scientific work After analyzing the subject carefully, I am led to venture the statement that chemistry, as we understand it is not a science in the strict sense of the term, although it cannot be denied that the enormous advance that has been made in the field of chemistry during the past century, is due in a measure at least, to what is known as scientific investigation and the application of scientific principles. Much of the success, however, if not the largest part of it, is due to the application of what is known as common sense, in contradistinction to so-called science.

Some one has defined science as "organized common sense," and this definition, to a certain extent, is true, but the common sense that I refer to is that which is, so to

*The Journal of the Franklin Institute.

speak, unorganized, and follows no given rule, but occasionally arrives at a conclusion in a problem, without any definite reason, except it be on the plea, that all great discoveries are the result of accident.

Taking the definition of science as organized common sense, or to use another expression, as systematised facts, this definition also implies the further use of knowledge thus systematised, and the distinction between a scientific and an unscientific mind, is that the former adheres to a system and applies it, or attempts to apply it to various problems, while the unscientific mind follows no definite line of action, and arrives at results by accident or by good luck at guessing

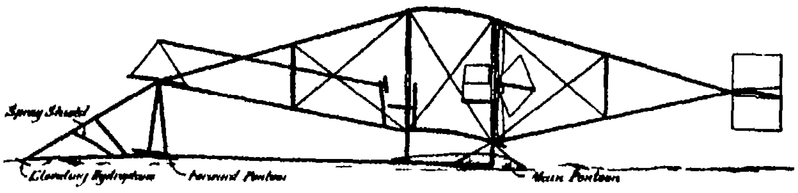


DIAGRAM SHOWING ARRANGEMENT OF HYDROPLANE FLOATS.

On the basis of the above definition of the term science and what it implies, it is evident that the most perfect science will be that in which the systematising of facts is most complete, and the degree of perfection will be determined by the extent to which the system can be applied and followed A perfect system is one that is based on a well-defined principle, in which every step is an application of this principle In this respect it will be found that mathematics is the most perfect system, for here the system is so perfect that its principle can be applied and followed to an unlimited extent. The conclusions reached are absolute and hold good for all time and under all conditions This is pure mathematics and it is pure science

In the applied sciences however, the systematising of facts is not so complete, and in consequence the systems are not perfect, and can therefore be followed only to a limited extent. The avowed principle of the system and the conclusions reached do not agree, although in some cases the disagreement may be so slight as to be insignificant Mathematical astronomy affords an example of the most perfect system of applied science for here while the systematizing of facts is not absolutely perfect, and consequently the conclusions are not absolute they are so nearly perfect that the conclusions reached may hold good for thousands of years to come The variations may be so slight as to be almost infinitesimal, but as long as the conclusions are not absolute, the system is not perfect In the final analysis the scientific mind fails, and the problem is solved by the unscientific mind, which makes a guess at the result by striking an average

The absoluteness of pure mathematics as a pure science, and the approximate absoluteness of the science of astronomy, may be explained by the fact that one factor only is taken into consideration in mathematics, namely, that of the relation between objects expressed in symbols, the physical properties of which are entirely ignored while in astronomy, it is the relation between planetary bodies, the physical and chemical properties of which, however much they may affect the final results, are also practically, if not entirely, ignored

In fact, as we proceed to explain science in general on this basis, and apply the explanation to the so-called sciences that involve factors whose physical properties must be taken into consideration, it will be found as the number of factors increases, that the systematising process becomes more difficult and impossible, while the purity and accuracy of the science decreases accordingly This will be observed as we pass from astronomy, where the factor is only one, or practically one, to mechanics, physics, chemistry, geology, biology, psychology, etc., the factors of which increase, while their accuracy as sciences decreases in the order named, until we reach sociology and theology, where the factors, consisting entirely of the vagaries of the human mind, become so numerous and antagonistic that any systematising whatever is practically impossible, and to these the term science has consequently no application.

It will thus be seen that the term science when applied to the various concrete sciences, has a very limited application, depending upon the number and complexity of the factors involved, and the pursuit of any of the so-called sciences in which the factors become numerous, would soon come to a stand-still, if it did not include the assistance of the unscientific mind; because a multiplicity of factors gives rise to problems, the solution of which is accomplished not so much by science as by empiricism. The tendency of the scientific mind, trained as it is, to look at problems along well-defined lines, in obedience to some system or law, is to ignore conditions and suggestions that do not seem to conform to these laws, with the result that valuable facts are often overlooked The tendency of the unscientific or practical mind is to go to the other extreme, and ignore laws and systems, and try any suggestion that chances to come along, with the result that while much valuable time and labor may be lost, the loss is fully compensated by a few valuable successes

I think it is safe to say that it is to the unscientific or practical mind that we are indebted for discoveries in the field of science, for it is only as we deviate from the well known and familiar paths laid down by the scientific mind that we stumble upon and discover new facts, and while the unscientific mind stands astonished and at a loss to know what to do with the discovery, it remains for the scientific mind to lay hold of the novelty and find a place for it in some general system of things It has been said that the difference between a discoverer and an inventor is that the discoverer is one who uncovers some new thing which he cannot make use of for lack of knowledge while the inventor is one who takes the novelty and by use of his accumulated knowledge, is able to recognise and make use of it by means of a so-called invention

REAR VIEW SHOWING MAIN HYDROPLANE FLOAT USED IN FIRST EXPERIMENT

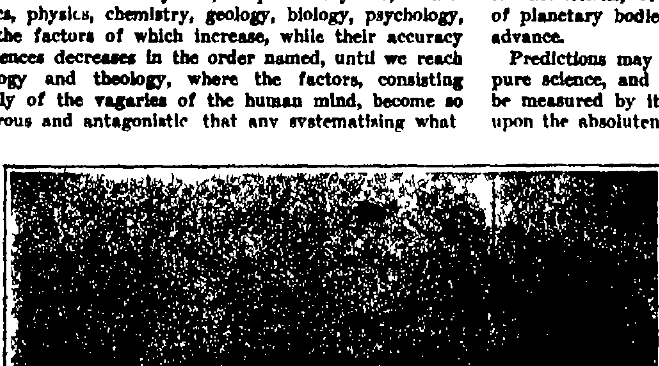
While science may be defined as the systematizing of facts, the ultimate object of the system is to arrive at or assume, if necessary, some law that will not only satisfactorily explain the facts, but will also enable us to deduce from the law new facts, or in other words to predict new facts or events Pure mathematics affords the best example of this ability to predict or make deductions, for its deductions are without limit Mathematical astronomy affords the next best example, for its deductions, or predictions, relating to the position of planetary bodies, can be made thousands of years in advance.

Predictions may therefore be considered a criterion of pure science, and the purity of a so-called science may be measured by its ability to predict, and this depends upon the absoluteness of the law or principle upon which the predictions or deductions are made, for where there is more than one principle involved, the deductions must be more or less antagonistic. In pure mathematics there is but one law or principle—"The whole equals the sum of its parts," and although there may be many corollaries to this law, the deductions are absolute and there can be no antagonism In astronomy also, there is practically but one law or principle, the law of gravitation, expressed in mathematical terms, and the deductions or predictions therefrom are almost, if not quite absolute The absoluteness of a principle implies absolute consistency of its application, for any deviation therefrom must necessarily involve the application of other principles. Pure science therefore is a system that involves an absolute principle and absolute consistency in its application

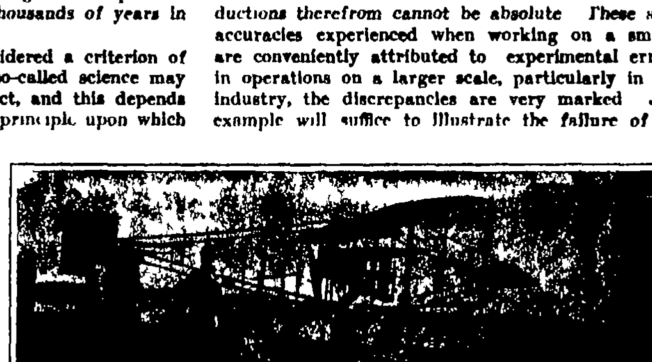
Now with this understanding of what constitutes pure science, let us turn to the so-called science of chemistry —does it involve but one law or principle, and do we or can we consistently apply this law to the various problems encountered?

Up to the time of Dalton it is well known that the study of chemistry was in a more or less chaotic condition, but after Dalton annunciated his so-called "Atomic Theory," and the same was generally accepted as a working basis, if not as a fundamental law of nature, chemistry became known as a science Why? Because here was a fundamental law or principle that was considered absolute, and could be consistently applied with the result that absolute deductions could be made upon the strength of it, and new facts or events could be predicted Thus we can predict that if the atomic proportions of Cl and H are as 35 to 1, then 35 parts of Cl combined with 1 part of H will produce 36 parts of HCl whether we take grains, pounds or tons of the materials We can predict that whatever quantities we can combine in chemical affinity we shall find the same quantities in the resulting compound and in doing so we have predicted a new fact or law known as the law of the "Conservation of Matter" By a combination of various laws deduced from the fundamental law, we get the law known as the Periodic Law," from which we can predict new and heretofore unknown elements

In so far therefore as the law of the Atomic Theory is applied in making deductions therefrom, and in predicting new facts to that extent, we may honestly say that chemistry is a pure science But in chemical investigation in research work, and in chemical industry, etc do we or can we apply this law to existing conditions and to the problems that confront us? Working on a small scale, where the only object is the demonstration of the law the application may so closely approximate the law as to warrant us in saying, on the basis of probability, that the law is applicable, but when the law is applied on a larger scale, as must be the case in chemical industry its limitations become very apparent. It would be difficult if not impossible to mention a single instance, where it is not necessary to alter calculations based upon deductions from the law, in order to obtain satisfactory results Even the atomic weights, upon the application of which the law is based, are not absolute and it is therefore self-evident that any deductions therefrom cannot be absolute These slight inaccuracies experienced when working on a small scale are conveniently attributed to experimental error" but in operations on a larger scale, particularly in chemical industry, the discrepancies are very marked Just one example will suffice to illustrate the failure of the law in its application—the manufacture of HNO_3 for instance. The law would require the combination of 179 parts of $NaNO_3$ with 98 parts of H_2SO_4, and on a very small scale in the laboratory these proportions might give results approximately accurate, but on a large scale using cwts. or tons, these proportions will not give accurate results by any means. That is not to say that the combination takes place in any other proportions



CURTISS IN FLIGHT AFTER RISING FROM THE WATER.



SIDE VIEW OF AEROPLANE SHOWING SINGLE PONTOON

THE FIRST FLIGHT OF A BIPLANE FROM WATER.

than those laid down in the law but that the proportions required to produce the calculated results, are not the same Here the deductions of the scientific mind fail and the unscientific minds steps in and by experimenting and guessing finally discovers that 95 parts of $NaNO$ instead of 172 must be combined with 98 parts of H_2SO to produce satisfactory results The proportions thus determined upon may then be accepted to a certain extent, as a working basis for the use of the so called scientific mind in working out future problems of a similar character

Here we see an illustration of the fact above referred to that discoveries are made by the unscientific or practical mind while the scientific mind endeavors to systematize the discoveries and thereby formulate laws for future use Both qualities are generally combined in the same individual in varying degrees and are essential for success in any line of work for discoveries unless they can be formulated into some system from which we can make deductions are useless, while on the other hand deductions alone from a supposed unchangeable law would soon become obsolete by reason of its limitations which are eventually revealed by new discoveries. If we possessed a universal law deductions therefrom would be without limit and discoveries which are now made by accident would appear as a process of evolution This is the case with pure mathematics in which there are no discoveries for each new fact is the result of a process of deduction or evolution

The principle of mathematics however as it is generally understood is not a universal law and although it is universally applied in all scientific work it must be remembered that there are other factors that enter into all problems each of which involves separate and distinct principles producing in the end an anomalous condition for where more than one principle is involved there must necessarily cease to be a principle In pure science as for instance pure mathematics there is but one principle involved and its application to symbols that have no intrinsic value involves no complex condition but in the concrete sciences we have besides the mathematical factor other factors principally physical chemical mechanical, and economical to say nothing of the temperamental known as the "personal equation all of which render the condition very complex and the application of an absolute law unless it be universal impossible This is particularly the case in connection with our so-called science of chemistry for the application of its principles involves all of the above extraneous factors and although they may be reduced to a minimum by the use of delicately adjusted appliances in connection with investigation work they are always present to interfere with the complete application of the principle

The question therefore "Is chemistry a science? If we answer it on the basis of the definition of science as organized common sense by which we mean a system involving an absolute principle from which we can make absolute deduction must be answered in the negative for as we have seen our deductions at best are only approximate and in the most important branch of chemical work industrial chemistry its application is more or less a total failure While it may be true that chemistry acquires the distinction of being called a science after the acceptance of Dalton's atomic theory as a working basis it cannot be claimed that the enormous advance since made in the field of chemistry is due to the application of this theory since in practical work we do not actually apply it at all Advancement is due rather to the inspiration that this theory affords by establishing a definite goal towards which concerted action may be directed for it is concerted action and unity of purpose among workers along any particular line that produce results

That chemistry is not a pure science, does not, however, imply that it is to be deposed from its position of importance among other so-called sciences, for the same condition applies to them all with the result that we have no real science except pure mathematics. Pure mathematics, however, limited as it is to symbols only, would be useless if it had no application to concrete things in connection with the other so-called sciences, and as this application is not perfect, owing to other factors present we must conclude that there is no such thing as a perfect science defined as "organized common sense"

To escape from this apparent absurdity, we are compelled to change our definition of the term science, and devise a definition that will apply to existing conditions. Instead of defining science as "organized common sense," we might define it as practical common sense," or as Prof James might call it, pragmatic common sense, that is to say the sense that makes use of anything that works All sense is common sense and the so-called organized common sense or science is judged, not by the degree of perfection of its system however necessary perfection may be as a criterion of pure science but rather is it judged by practical considera tion by results

Human nature is practical if it is anything and a theory no matter how profound it may be, even if it be a theory of life has little interest for us if it is not practical When a new theory is propounded, our first question is not is the theory true, but, will it work will it deliver the goods If not we have no use for it We judge a theory or system or any line of work, solely by practical considerations and these practical considerations are not academic but humanistic not scholarly attainments but things that add to the happiness and comfort of mankind

Human nature looks for immediate returns and of all lines of work can there be found one that gives for labor expended more satisfactory returns than that which is included under the name of chemistry It is ostensibly based on a fundamental principle and although the results may not accord with the principle the results are nevertheless, approximately what we are looking for which is achievement and even if incomplete we are satisfied to call it a science If its field of operations were confined to purely scientific work where the only object is the relations between hypothetical atoms its usefulness would be so limited that its work would be no more productive of happiness than astronomy which deals with the far distant planets or the study of metaphysics that deals with things transcendental

In fact the field of operations open to chemistry is unlimited and there is no important line of practical work in which mankind is interested that is not in some way related to chemistry On the other hand the field of practical chemistry is not limited to so-called relations but includes within its applications many conditions that are not strictly speaking chemical at all but mechanical, physical geological biological and even psychological From a practical point of view we might say that chemistry is the science of all sciences for it seems to include them all in one great whole From determining the elements of the stars down to analyzing our foods from steel making to farming chemistry is an important factor without the assistance of which no industry can hope to succeed Consequently its problems which we started out to discuss are of a most varied character and their solution requires not only a knowledge of chemistry but a thorough knowledge of all the other concrete sciences combined and most of all an appreciation of the fact that success is counted not by the profoundness of a theory but by practical attainments Chemistry as a science is as simple in its operations as the multiplication table and involves no greater problems because its application is confined to symbols, that give rise to no counteracting conditions. Real problems arise when application is made to concrete things, that involve not only chemical conditions, but physical, mechanical, economical, temperamental, etc. Temperature, concentration, and so-called "mass action," form, size and construction of implements and utensils employed are all factors that must be harmonized and systematized, and this harmonizing process is what constitutes the problems of chemistry, problems that no scientific mind alone, much less, a purely chemical mind can solve. They are solved only by the broad, common sense, "pragmatic" mind, that is fortified with a knowledge of things in general, and often by the mind that boasts of no knowledge whatever, for as is sometimes the case, problems are solved by an ignorant mind, because unhampered and unprejudiced by preconceived laws whose supposed fixedness often interferes with freedom of thought.

Just where to draw the line that distinguishes a chemist from another worker, is a difficult, if not impossible task, for if we define a chemist, as one who is engaged in solving problems in the field covered by chemistry an industrial plant for instance, then we must include every individual connected with the plant, from the officers down to the common laborer for each in his own sphere, is engaged in working out some problem connected with the industry Consequently, a chemist, an industrial chemist in particular and all chemists are supposed to be industrial in some capacity is one whose occupation is that of solving problems arising primarily out of the chemical changes that are constantly taking place in the material universe, but which ultimately embrace every condition that contributes to the material happiness and comfort of mankind In fact his occupation is philosophical rather than scientific for instead of looking at things from a scientific point of view, that is from a fixed and limited principle, he learns to look at them from all points of view, which is the philosophical view

It has been said that to gain an education is to cultivate an attitude of mind that is to learn not merely to look at things but to learn how to look at them To merely look at things, is to look at them from one point of view which results in narrow mindedness prejudice and bigotry while the philosophical view cultivates a broad minded, altruistic attitude of mind and is productive of the greatest success and the greatest good to mankind

This is a point that might well be impressed upon chemical students lest they become deluded with the idea gathered from their study of the theory of chemistry that problems can be solved by the application of fixed principles and unchanged laws unconscious of the fact that their solution is in the end accomplished by adjusting and harmonizing conditions that are antagonistic and incompatible with any fixed principle that may be laid down in a text book Instructors in the natural sciences are too prone to impress upon their scholars the absoluteness of the laws of nature without taking the necessary precaution of drawing a distinction between theory and practice between science as organized common sense, and science as practical common sense The most successful chemist is the one who combines a well balanced amount of both the scientific and the practical mind for the problems that will confront him quire for their solution the broadest possible attitude of mind Even those who have had many years of experience are sometimes liable to be two scientific and to rely too much upon scientific deductions, as for instance when we have worked out some method to approximate perfection on a small scale and then make an attempt to apply it on a larger scale only to meet with failure and financial loss because some unforseen factor has arisen that intereferes with the operation

Summary of the Fifth Annual Report of the Carnegie Foundation

The fifth annual report of the president of the Carnegie Foundation covers the year ending September 30th 1910 The report is divided into two parts Part I pertains to the current business of the year Part II is a discussion of the Relation of the College and the Secondary School

The report shows that the trustees had in hand at the end of the year funds amounting to \$11 114,056 86 consisting of the original gift of \$10 000 000 par value of five per cent bonds and one million accumulated surplus The income for the year was \$543 881 90 During the year 64 retiring allowances were granted of which 46 were in accepted institutions and 18 in institutions not on the accepted list During the year 23 pensioners died

Among distinguished teachers who retired during the year were Professor Burt G Wilder of Cornell; Dean Van Amringe and Professor Chandler of Columbia both well advanced in years and in academic honors; Professor George L Goodale the famous botanist of Harvard Professor Osborne of the Massachusetts Institute of Technology who has taught mathematics in that institution since its foundation; Chancellor MacCracken of New York University President Seelye of Smith College and Professor Calvin M Woodward of Washington University St Louis These distinguished men average in age seventy two years and illustrate how well the vigor and influence of the scholar can be continued to a ripe maturity

There were admitted to the accepted list during the year the University of California the joint institutions of the State of Indiana Indiana University and Purdue University—and Wesleyan University the last named a college

In the first part of the report the president of the Foundation follows up the bulletin on Medical Education by a paper on the Relation of the University to the Medical School in which he calls attention to the responsibility attaching to any college or university which undertakes medical education

The second part of the report is a careful attempt to state the existing causes of friction between the secondary school and the college and the loss of educational efficiency in the present methods of bringing pupils from the school to the college The complaint of the college against the secondary school and the complaint of the secondary school against the college are set forth

An extremely interesting part of the report is a statement of the observations of Oxford tutors upon the preparation of the Rhodes Scholars The strong points in the American boy's preparation are readily seen by these trained teachers, and the weaknesses which they find point directly to the superficiality and diffusion of the work done in the American secondary school and college

The president of the Foundation urges that this whole question be approached by secondary school men and college men in a spirit of co-operation Neither the certificate method of admission nor the piecemeal examination method have in his opinion solved the problem He urges that the college must find a solution which will test better than the certificate or the piecemeal examination the fundamental qualities of the student, and which will at the same time leave to the high school a larger measure of freedom He recommends a combination of certificate and examinations, the latter of a simple and elementary character but calling for a high quality of performance without which the candidate will not be admitted For example under this plan the boy who cannot write good idiomatic English would not be admitted to college at all, but would be sent back to the secondary school The entrance requirements recently adopted at Harvard are quite in line with these recommendations The president of the Foundation urges a co-operation between the secondary school and the college not as unrelated institutions but as two parts of a common system of education He argues that the interest of the great mass of high school students must not be sacrificed to the interest of the minority who are looking toward college He insists on a larger measure of freedom for the secondary school but on the other hand he argues that the interest of the boy who goes to college and the boy who goes from the high school into business are alike conserved by learning a few things well, not by learning many things superficially The boy who has obtained such intellectual discipline is a fit candidate for college, whether he has studied one set of subjects or another without this intellectual discipline he is unfit alike for college or business It is therefore, in the opinion of the president of the Foundation, the plain duty of the college, at the present stage of American educational development, to articulate squarely with the four year high school and to leave the secondary school the largest freedom so that it may educate boys, not coach them; but at the same time to require of the candidates for admission tests which rest upon high performance in the elementary studies and which mean mastery of the fundamentals In such a program lies the hope of scholarly betterment and of civic efficiency for both college and high school

On the 28th of April the railroads of Russia will pass under the control of the Imperial Russian Technical Society This day also marks the opening of an international exposition in St. Petersburg devoted particularly to the application of electricity to railroad service

The Gold Dredging Industry

Old and New Fields for the Dredger

By Charles Janin

It is the contention of most engineers and operators familiar with the conditions, and is undoubtedly true to a great extent that the limits of dredging areas in California have already been fairly well defined, and that the greater portion of the field is controlled by the large interests. Other engineers are more optimistic and believe that tracts which have previously been passed over, or reported on unfavorably, when prospected some years ago still hold possibilities for the future. With the great advance made in the industry and the development of the modern dredge, from the earlier successful boats with their 600 cubic yards per day capacity to the boats with 16-foot buckets and the estimated capacity of 300 000 cubic yards per month, and the reduction of working costs, under favorable conditions, to less than 3 cents per cubic yard, it is obvious that areas which a few years ago were considered too low grade to equip with a dredge will under present conditions, again attract the attention of those interested in the dredging industry.

In Alaska there is a growing demand for dredges of the smaller class, having 2½ to 7 cubic foot buckets, a number of which have been installed in the last year and several of which are planned for 1911. In addition to these smaller boats, the Far North can boast of one of the largest dredges yet constructed, a Marion 16 foot bucket dredge installed on the Boyle concession in the season of 1910. This boat has a total weight of 900 tons and will dig approximately 10 000 cubic yards per day. On this same property a Marion 7 foot bucket boat has been successfully working since 1906 and is still in good condition for the past season it is said to have averaged 3,700 cubic yards per day.

Besides the possibility for new dredging areas in California and other western states and in Alaska the attention of dredge operators has been attracted to the many opportunities for the installation of dredges in foreign countries. Much interest has been manifested in Siberia of late and a number of American engineers have been engaged during the past year in the examination of Siberian gravel properties. A number if not all of these examinations resulted unfavorably some on account of the low grade of the gravel others because of severe business conditions or exorbitant prices imposed by the owners. However there is no question that so far as operating conditions are concerned there are areas of gravel in Siberia that can be profitably worked. Recent reports from the dredges operating in Siberia show an increased working efficiency both in the yardage handled and the percentage of gold recovered per dredge.

Recent engagements of experienced engineers for West Africa indicate that it is being more seriously considered as an attractive field for dredging investments. Some of the first dredges there as in other fields were failures but the employment of competent men is the first step toward obtaining reliable knowledge of existing economic conditions, and securing the installation of suitable dredges when they are warranted. This practice if more often followed would save investors much money and give a far better tone to the mining business in general.

It may be said that the majority of dredges placed in South America have been unprofitable. This has been due in part to a failure to recognize or to properly appreciate the difficulties of installing and operating a dredge under the conditions existing in South American countries and in part to equipping a property with unsuitable dredges on ground the value of which was optimistically guessed at rather than determined by careful sampling.

The most important dredging work in South America is that on the property controlled by the Oroville Dredging Ltd on the Nichi River in Colombia. The area was carefully examined by capable engineers and is probably the first South American property to be drilled and prospected in the systematic manner in which such work is done in California. Over 300 acres were proved to be profitable dredging ground. The company has a concession of 22 000 acres, the greater portion of which has not yet been prospected. A hydro-electric plant has been built and an 8½ cubic foot bucket dredge (California type) with steel hull will be built.

In French Guiana dredging has been tried so far on three rivers only the Carcibo, the Sparwin and the Lisard. Three new dredges are in course of construction in those places an indication that the first results, either in dredging or in prospecting have been encouraging. There are in French Guiana other rivers equally rich. According to the latest reports, a new dredge operating in Roche Creek carefully prospected in 1908 has given an output of 8 kilogrammes in March and 10 kilogrammes in April, 1910 (1 kilogramme of this gold is worth about $500). Experiments extending over a period of six months were made with an English dredge of 1 000 cubic meters estimated capacity a day but which owing to difficulties of operation was unable to wash more than from 300 to 400 cubic m in 24 hours. These experiments are said to have demonstrated that the cost of operation in handling this amount of gravel was from 36 to 42 cents per cubic yard.

An entertaining account of the Goldfields of French Guiana," by Albert Bordeaux from which the above paragraph was abstracted appears in the Trans Amer Inst Min Eng for November 1910.

In British Guiana dredges are successfully operated where the gravel is much lower in gold content than that of French Guiana. It might be that better results could be obtained in French Guiana by employing convict labor but thus far experiments in this direction have been far from encouraging, another attempt is to be made on a placer near S Jean du Maroni.

In Dutch Guiana gold dredging has been carried on along the Saramacca and Marowijne rivers with small Holland built dredges.

In Mexico several gravel areas have at times attracted attention. A dredge was installed at Suaqui Grande Sonora, some years ago but was not a success. Other places in Sonora along the Yaqui River near Tonichi and San Antonio were prospected with Keystone drills with indifferent results. A prospecting party is now drilling at the latter place but reports from it are not encouraging. The dry placers of Altar have been brought into prominence recently by the success of the Quenner dry washing machine. In Sinaloa there are places where it is claimed that the ground could be profitably dredged. The present outlook for gold dredging in Mexico however is not brilliant.

Among other fields that may be mentioned as offering possibilities for gold dredging are Korea China and the Philippine Islands. In Korea tests have been made of gravel areas and it has recently been reported that a dredge is to be erected. In China there has been no dredging but engineers consider that there are areas in the northeastern part which are worthy of investigation. The only successful dredging in the Philippine Islands has been carried on in the Paracale district which is situated in the northern part of the province of Ambos Camarines on the eastern coast of the island of Luzon. It has been described in "The Mineral Resources of the Philippine Islands" published by the Division of Mines of the Bureau of Science. The placer ground in the vicinity of Paracale generally consists of about four or five meters of barren clay mixed with organic matter overlying a varying amount of gray clay carrying small quantities of gold. Below this is an irregular layer of sand and quartz pebbles in places showing large amounts of free gold. Dredging operations have been carried on by the Paracale Gold Dredging Co, a New Zealand corporation the Stanley Paracale Co whose dredge is at present shut down and the Philippine Gold Dredging Co which bought a dredge originally erected on the island of Masbate. This last dredge was found unsuited to the ground on the Paracale River and was again moved this time to the Malaguit where it is said to be successfully worked.

The Paracale River is really an arm of the sea with a tide rise and fall of some 5 or 6 feet. The flat in which it runs is perhaps a mile wide near the mouth. It continues about the same width for a mile or more and then spreads out into smaller flats with ranges of hills between. The total area available for dredging in this flat is estimated at 1,300 acres. The average depth is 30 to 40 feet on the lower river; but higher where the Stanley dredge is working the depth is considerably less. The Malaguit River which flows into the Pacific not far from the Paracale has been prospected with hand drills. There is a much larger percentage of gravel and heavy material there than on the Paracale. Several other streams in the same district have been prospected to some extent, with results not altogether favorable. Low hills and ridges divide the tidewater streams, and except where cleared by the natives for growing hemp, are covered with heavy timber and a dense undergrowth, so that prospecting is difficult.

In Burma there are numerous gravel areas, some of which have been worked for generations by the Burmese who employed a rude method of ground sluicing. A number of these areas have been more or less thoroughly prospected and several dredges have been built, a number of which were failures. According to J Malcolm Maclaren in Gold Its Geological Occurrence and Geographical Distribution:

Of all Burma's numerous auriferous alluvial deposits none has been considered worthy of extended trial except those owned by the Burma Gold Dredging Co above Myitkyina. There three dredges were at work in 1907 with results considered so satisfactory that a fourth dredge of greater capacity was being built.

Figures for the past year are not at present obtainable but according to an article in The Mining Journal in November 1909 these three dredges worked six days a week for an average of 46 weeks and turned over a total of 1 918 000 cubic yards for the year with a total recovery of £32 000 ($155 520) or 8 cents per cubic yard. The operating cost including management is given at 3¼ cents per cubic yard. It is possible that dredges will be placed on other properties a California type Bucyrus boat has in fact been ordered by the Mewaing Gold Co Ltd.

In Japan according to a report recently issued by the Bureau of Mines:

From early times many placer workings have been carried on in the river beds or terraces along the river sides in the districts of Kesen Wakuya Hayakawa Abekawa, Yoshinogawa etc. Recently they have begun to be worked in many localities in the Hokkaido, and the River Kilung in Formosa. Up to the present time only the surface placers have received attention for which reason no gold dredging or underground working has been attempted. The largest nugget ever found in Japan weighed only 27.1 ounces and was found in the gold bearing gravel at Yesashi. The greater part of these deposits are in the Alluvium while a few of them are discovered in the Diluvium yet we never find any Tertiary placers.

In tropical countries there are many drawbacks that should be thoroughly understood by anyone purposing to invest in mining properties. Often rough mule trails are the only means of entering a district and the transportation of heavy machinery would be impossible until some kind of a road was built. Attempts to sectionalize dredges have not been as successful as with other classes of mining machinery. In Guiana the only means for transportation of machinery along the rivers is by canoe. One dredge failed to reach its destination because the hull pieces were too large to be taken over the first rapids. They are still to be seen along the trail. The attempt was made to remedy this loss by building a wooden hull on the ground but in that climate insects and worms destroy wood in a short time. The next hull ordered was made in smaller pieces.

Climatic conditions in the tropics are generally trying; the heavy rainstorms during the long wet seasons and malaria and beri beri are to be contended with. The inefficiency of native labor is also a serious matter though in some cases it has been possible to instruct natives to operate a dredge with a white overseer in control. There is always difficulty in securing and maintaining an efficient and honest staff of white labor so far from home and it is generally necessary to have a reserve corps to fall back on when occasion requires.

One engineer who has some interesting figures from an extensive examination in Colombia, mentions that his white assistants were incapacitated 16 2/3 per cent of the time from sickness. On another trip the young engineer in charge contracted a fever which proved fatal. In foreign countries as elsewhere in making investments in dredging much money may be saved and disappointment avoided if prospective investors will insist upon having reports by experienced engineers rather than listening to the advice of optimistic incompetents, and going blindly into enterprises that, to be an economic success, require experience and good judgment in every phase of the work.

* Condensed from an article in the Mining and Scientific Press of Dec 31st 1910.

The Block Signal on the New Paris Subway

The block signal system used on the new Paris north-south subway introduces an improvement over the former practice. When a train is stopped in the tunnel, all the other trains on the line are stopped and also in the tunnel. It is desired to prevent this and to allow the other trains to reach the next station before stopping. A special green light known as "permissive signal," allows of doing this. At the entrance of the block there are three signal lights, white, green and red and at the end, white and a double red light. When the train leaves the station, it automatically throws on the double red outgoing signal, so that if a train comes in the rear it finds the entrance signal at green (permissive) which shows that it can enter the station, but that there is a train in front of it within the tunnel. The rear train enters the station but is stopped there by the double red outgoing light. When the fore train reaches another station it annuls one of the red lights. The back train is still stopped by this red light, but it knows that the fore train has now reached a station. When the front train leaves its station it puts on the white light for clear track as usual. The green light is here used exceptionally as a "permissive signal" so as to allow the rear train to come into the station, but it can go no farther as it is stopped by the double red light or the single red. Thus the principle is kept of separating two trains by two red lights, but the two are now condensed on the same outgoing signal. By this method all the trains can enter the stations in front of them, even if one should be blocked in the tunnel, and the passengers can be discharged. On the old system when one train was stopped in the tunnel, all the others are likewise stopped and could not enter the stations.

Electric Works for the Production of Cast and Forged Steel

An electric steel works has been installed on a large scale at Dommeldange Luxemburg. It produces cast and forged steel and is now running at full production. Three blast furnaces give 330 tons of iron per day. For the steel process, Wellmann Talbot heating furnaces and Kjellin electric furnaces are used. Two of the latter are now in operation for use on single-phase current, and a third furnace is adapted for three phase current. The plant makes extensive use of blast furnace gas for running gas engines and also as boiler fuel. Steam turbines are run from the boilers. Especially noteworthy are the large Augsburg gas engines which are of special design for use in operating on the blast furnace-gas. This is first passed through scrubbers before going to the engines.

The Famous Astronomical Clock of Venice

The Church of St Mark and the Torre dell Orologio

By Charles A Bressler

The attention of the entire civilized world was recently attracted to Venice the white swan of cities, by the news that the Campanile one of the architectural attractions of the renowned plaza of St Mark which collapsed and was a heap of ruins in 1902 has been successfully rebuilt The disaster was attributed to the insecurity of the foundations in the swampy bottom and it was feared that other historical structures fronting on the show place were threatened with a similar fate The fact that this would be regarded as a catastrophe of world wide significance induced the Italian government to investigate the conditions of these historical structures, which include the Doge s palace the Church of St Mark and the *Torre dell Orologio* (clock tower) so called from its being the location of the famous Astronomical Clock of Venice

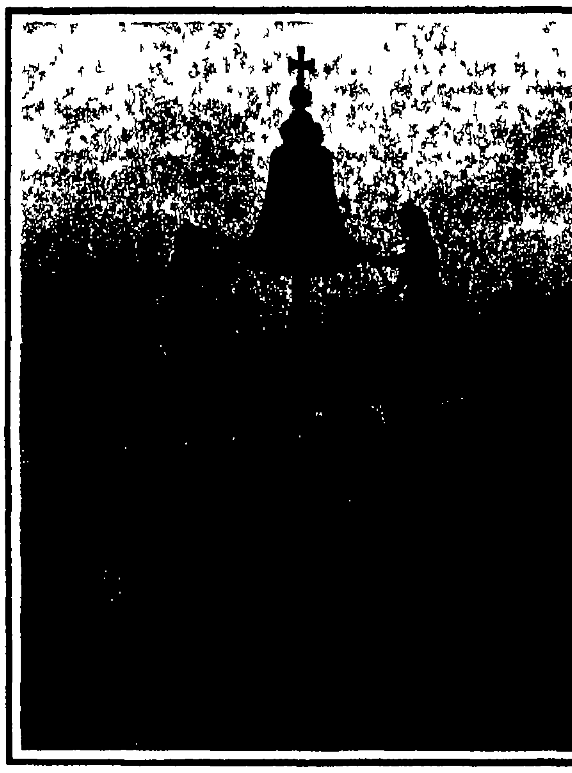
This last named building which is seventy feet in height and is of solid white marble with decorations consisting of panels of colored Carrara marble and mosaics of gold and lapis lazuli was erected for business purposes as early as the fifteenth century the archway in the center giving access to the *Merceria* the commercial center of Venice where the principal stores are to be found and the best retail trade is carried on Pietro Lombardo was

Projecting from the front of the tower above the clock is a balcony, in the center of which sits the Virgin Mary enthroned, a gilded figure, on a background of blue and gilded lattice patterns holding the infant Jesus on her knee, the figures being flanked by two doors, overlaid with gilded work Four times a day the doors open and a procession makes its appearance from the door on the right, first an angel blowing on a golden trumpet, then in turn the three kings or wise men from the East—Melchoir Caspar and Balthasar Each in passing raises his hand and bows his head, in salutation of the mother of God, enters the door on the left and disappears, the doors closing after the last figure has entered The procession moves before the Virgin at three six, nine and twelve o'clock and our special photograph showing this portion was taker at the moment when they were passing in front of the throne On a console above the canopy under which the Virgin sits, is a massive figure in bronze of the winged lion of St Mark Surmounting the tower are two bronze figures of Moors—the "bronze giants of Venice"—who strike hours and quarters on two large bells, hung one within the other

It is related of these figures that on one occasion, something having gone wrong with the striking mechanisms,

per minute, but it was found that 6000 revolutions was sufficient. In this work it was not sought to use the inertia of the gyroscope directly for the steadying, but the gyroscopes were employed for automatic working of the rudders charged with balancing the aeroplane at each instant. To carry this out, the gyroscopes were placed in a case which could turn by trunnions about an axis perpendicular to the rotation axis of the gyroscope. If the trunnion axis is placed in the direction of moving of the aeroplane, for instance, and if the aeroplane tends to incline upwards or downwards, the gyroscope reacts against this inclination by the movement which it has around the trunnion axis. Such movement is transmitted to the rudder by suitable connection. A first set of tests was made with the gyroscope and the rudder mounted together on a swinging frame like a large balance arm and working from a fixed point. The governor took the wind from the blowing machine used in Colonel Renard s experiments on airship models. Under these conditions, when the balance of the system was disturbed either by shifting movable weights on the arm or by bearing against this arm, it was seen that the rudder worked by the gyroscope gave the equilibrium automatically A second series of tests was

THE CLOCK JUST AT THE MOMENT WHEN THE THREE WISE MEN OF THE EAST ARE PASSING BEFORE THE VIRGIN AND INFANT



THE GIANT BRONZE MOORS STRIKING HOURS AND QUARTERS OF THE GREAT VENICE CLOCK OF ST MARK S

THE FAMOUS ASTRONOMICAL CLOCK OF VENICE

the architect of the tower which was built in 1494 the wings on each side also built in the style of his school were not erected until the beginning of the sixteenth century

The first clock installed in the tower was made by Giovan Paolo Rinaldi of Reggio and Gian Carlo, his son but in 1750 it was badly damaged by lightning and Ferracina of Bassano reconstructed it in 1775 Evelyn in his memoirs under date 1645 evidently refers to the first clock when he describes it as next to that at Strasburg for its many movements some of which he mentions his description indicating that many of the features of the original clock have been embodied in the present timepiece

One of our illustrations shows the great dial of the clock and the automata with which it is surmounted The dial bears on its outer circle the hours from 1 to 12 in Arabic figures twice repeated making the twenty four hours used in the Italian system of dividing time but subdivided to make them comprehensible to those accustomed to other methods of division The inner circle shows the signs of the zodiac and revolves at such speed as to show the months in their relation to the period The hour is indicated by the single hand there being but one in accordance with the old system of clock construction The body of this hand is concealed behind the center of the clock only the point in the form of a blazing sun showing beyond the groove between the first and second circles in which it travels around to point the hours The center of the clock is of black enamel spangled with golden stars to represent the heavens Its center is occupied by a golden sun around which a globe, half black half gilt makes a complete revolution in twenty-nine and a half days, reproducing the phases of the moon.

an attendant went up to investigate Incautiously, he ventured too near the hammer of one of the giants as it came into action was struck on the head and hurled to death on the pavement of the plaza Our photograph shows the figures outlined against the sky in the act of striking the bells

At the Franco-British Exhibition, held a short time since in London, a model of the old clock with the tower, twelve feet in height and closely following its construction as to materials, etc was exhibited It was beautifully executed and reproduced exactly the movements of the celebrated clock

It is to be hoped that every precaution will be taken by the proper officials to ascertain whether there is really any risk of further damage to the buildings grouped about the square of St. Mark of the nature that resulted in the destruction of the Campanile The world can ill afford to lose such specimens of the mechanical skill and artistic taste of bygone generations as the clock tower we have just described and the remaining edifices that make the Plaza of St Mark in the city of the Doges an object of interest to artistic pilgrims and students of human progress from all over the world

Gyroscope Rudders for Steadying Aeroplane Flight

New experiments have been made in France by M Girardville in the use of the gyroscope upon aeroplanes for steadying them when in flight. The author carried on experimental work at the Chalais-Meudon military aeronautic establishment near Paris The gyroscopes used here were constructed by M Delaporte and the revolving mass weighs 8.8 kilograms (19¾ pounds) The speed of rotation can reach 10,000 to 12,000 revolutions

made by transporting the whole to the top of the Eiffel Tower and operating under violent and often irregular winds of 40 to 50 feet per second The results were identical with the foregoing It should be remarked that at the beginning of the present work, the tests were hindered by the fact that under the action of the gyroscope rudder, the balance arm swings about its pivot and these movements may be very strong Such effects were, however all eliminated by using a dash-pot composed of a flat plate working in a vessel of water After making the above tests with fixed apparatus, M Girardville proceeded to try actual flights, and placed gyroscope rudders on aeroplane models, first unmanned and then upon aeroplanes without motors, mounted by an aeronaut, such as were used for simple gliding in former aeroplane work Such tests showed him that even with small sizes, having but 19 square meters (199.2 square feet) surface, the air reactions on the surface were enough to replace the effect of a dash-pot, so that in air flight there was no oscillation noticed. He made a number of flights, unbalancing the aeroplane by shifting the weight and working in irregular winds, and found that the gyroscope rudder always worked in the desired direction and enough to bring back the equilibrium. At present he is engaged in making experiments with aeroplanes carrying motor at the Vincennes military establishment at Paris, and is having encouraging results. During the first tests the motor operated the gyroscopes by flexible shaft and friction rollers Since then he adopts another method and secures good results by using an extra helice of small diameter which is placed so as to turn, under the action of the wind from the main aeroplane helice. The small helice thus drives the gyroscope by suitable mechanical movement.

The Pygmy People of Africa

Prof Starr's Discoveries in the Jungle

By Ethel Claire Randall, Ph M

In his Preface to Schweinfurth's "The Heart of Africa," Winwood Reade surmises that the pygmies were the original natives of Africa and that they "may be considered as the scattered remains of an aboriginal population now becoming extinct; and their isolated and sporadic existence bears out the hypothesis"; a supposition corroborated by De Quatrefages, who thinks that formerly these little people "formed populations denser and more continuous, that they have been crowded back, separated, divided, by superior races," and again, "whenever one meets with them to-day one sees them retreating, and often dying out." Keane, in spite of his cut-and-dried table of descent, holds a like view regarding the communities of little people as "all being scattered fragments of a primeval dwarfish race, who are to be regarded as the true autochthones of equatorial Africa" Stanley dwells upon the same thought: "These little people have roamed far and wide From the Niger banks, with successive waves of large migrants, they have come to pitch their leafy huts in the unknown recesses of the forest." "Their kinsmen are known as Bushmen in Cape Colony, as Watwa in the basin of the I ulungu, as Akka in the Monbuttu as Balia by the Mabode, as Wambutti in the Ihuru, and as Batwa under the shadows of the Lunae Montes"

Of the tribes going to make up the sum of this common dwarf race in Africa, the bulk of material accumulates about the *Akka*, the *Obongo*, the *Batwa*, and the *Wambutti* and still another small people, the *Bushmen*, concerning whom much has been said and written by way of contradictory opinion as to their connection with the members of the accepted pygmy race The first of these the *Akka* we are told appear to occupy a continuous area and to number nine distinct tribes, each with its own chieftain In comparison with the other races among whom they live, Schweinfurth states that they differ from them in scarcely any particular beyond the matter of height and in the tone of the complexion which is redder or brighter in shade He measured six adult males and a boy not yet grown None exceeded materially a height of four feet ten inches His statements are verified by those of Marno, Giglioli Chaillé-Long and Vossion

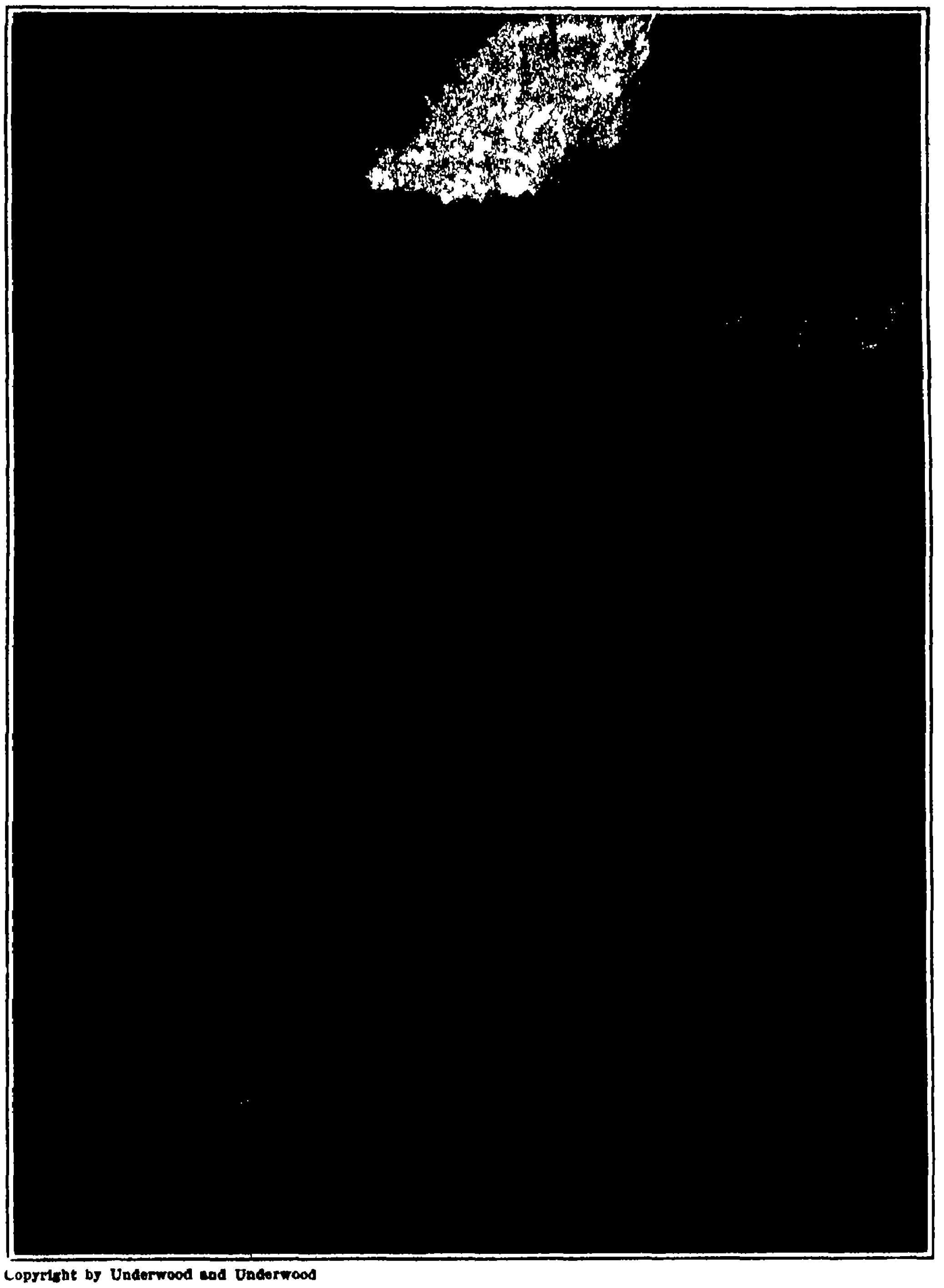
Junker fell in with the *Wochua* whom he assures us the the same as described by Scweinfurth though they call themselves *Achua* or *Wochua* indifferently in distinction to the name *Akka* or *Tickitikki* given them by the Arabs and *Affi* by the surrounding natives They are feared by those in their vicinity and pick and choose which tribe they will live near avoiding some consistently and neighboring with others whose chiefs frequently engage their help in warfare Their custom is to horde together in small communities rarely exceeding one hundred individuals nevertheless they have made their presence so thoroughly felt in their outskirts that they oftentimes stick an arrow into a bunch of green bananas, whereupon the owner not daring to pluck it, leaves that particular cluster to be claimed by them when ripe.

Du Chaillu in 'Equatorial Africa and the Country of the Dwarfs," speaks of a tribe of hunters in the neighborhood of the Niembousi totally unlike the *Ashango* in whose territory they live These *Obongo* frequently move from one place to another always taking care however to stay within certain confines They plant nothing It is not unusual for them to steal from the *Ashango* then decamp immediately to some more remote part of the district Yet, in spite of this, the *Ashango* are kind to the little folk, even appearing to like to have them in the neighborhood inasmuch as they can get exchange of meat from them for the agricultural products and manufactured articles such as iron implements, cooking utensils water-jugs and the like The *Ashango* and the *Obongo* however do not intermarry Their disposal of the dead is curious The corpse is put into the interior of a hollow tree, found somewhere deep in the forest, and the opening is closed with leaves, branches and earth. Still more interesting is the account vouched for by the *Ashango* who say that at other times the pygmies turn the current of a running stream in order to make a hole in the river-bed where they may place the body, and having suitably covered it allow the water to regain its accustomed course. Their dialect presents a mixture of their own original language and of that of the various tribes with whom they have come in contatt.

"In Darkest Africa" Stanley makes the statement that there is no evidence of polygamy and every evidence that domestic ties are strong among these little people Each family has its own hut, a low structure of the shape of an oval figure, cut lengthwise, fashioned of the stalks and leaves of the phrynia Other huts—those peculiar to the *Wambutti*—are elevated and made in a cone shape running to a sharp point from which emerges a central support projecting above the grass-thatched roof The huts are usually arranged in a circle with the doors varying from two to three feet in height, facing inward toward a hut in the center occupied by the chief and his family These miniature villages are planted in the midst of the forest several miles distant from a tribe of agricultural aborigines, and it is not uncommon occurrence for a large clearing occupied by big blacks engaged in tillage of the land to be surrounded at intervals by as many as a dozen communities of pygmies, aggregating in all perhaps two thousand five hundred souls. The approaches to a village are indicated by a series of diamond cuttings in the roots of trees across the track leading to it and at a distance of approximately five hundred yards, while within a hundred yards of the camp, along every trail leading to and from it, is a sentry box large enough to accommodate two persons and with a door facing the track, placed there as a toll gate for caravans. The occupation of the pygmies is hunting and fishing, and scouting for their agricultural neighbors, who, from the nature of their pursuits, are a settled community They are keen woodmen Large game they stalk in bodies and bring down by baiting with hundreds of arrows till it falls Game smaller or less agile than elephants buffalo and antelope, are trapped in pits covered lightly with sticks, leaves, and earth, and surmounted by a shed like structure with the roof suspended from a vine in order that it may fall at the right moment Animals still smaller than chimpansee, baboons, etc., and birds, are captured in bow-traps fashioned in such a way as to strangle them. The weapons of the dwarfs are tiny bows, and arrows tipped with metal, sometimes steel and poisoned, as well as spears and probably axes, since Stanley noticed that the trees in the vicinity of the pygmy camps were scored with ax cuts The division of labor is practically that known to every people in the state of barbarism: the women do the cooking, collect the fuel and the provisions, as well as carry the household goods when the camp moves, which it does whenever game becomes scarce in one region; the men employ themselves in making traps for game, nets for fishing, in working iron and steel, in carving ivory, which they cut into fantastic designs for bracelets, anklets and necklaces, and in manufacturing the deadly poison with which they smear the tips of the iron arrow-heads and lay thickly on the splints such as are made from wood.

Stanley relates, further, that he met with two types of dwarfs, the individuals differing from one another in complexion shape of head and in facial characteristics "Whether the *Batwa* forms one nation and the *Wambutti* another" he says, 'we do not know but they differ as much from each other as a Turk would from a Scandinavian He captured one of the dwarfs said to live north of the *Wakuma* country and later four women and a boy, one of whom evidently belonged to the *Akka* for she had "small cunning monkey eyes close and deeply set The other four possessed large round eyes full and prominent, broad round foreheads and round faces small hands and feet with slight prognathism of the jaws figures well formed though diminutive and of a brick tint complexion The monkey-eyed woman had a remarkable pair of mischievous orbs protruding lips over hanging her chin a prominent abdomen narrow flat chest, sloping shoulders long arms, feet turned greatly inwards and very short lower legs as being fitly characteristic of the link long sought between the average modern humanity and its Darwinian progenitors, and certainly deserving of being classed as an extremely low degraded, almost a bestial type of human being One of the women was of perfect proportions and "appeared at first to be but an undersized woman; but when we placed some of our Zanzibar boys of fifteen and sixteen years old by her side, and finally placed a woman of the agricultural aborigines near her it was clear to everyone that these small creatures were a distinct race"

Others who have discussed the *Batwa* are Dr Wolf Mr Hinde Mr Verner and Dr Starr A number of the points made by Dr Wolf have already been mentioned But their method of drying meat upon stagings over the fire has not been spoken of, nor their disposal of such



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PROF STARR AND ONE OF THE PYGMIES

cured meat to the large negroes upon set market days held on ground common to the two camps Dr Wolf notes the servile position occupied by the dwarfs among their big neighbors and remarks, finally, that the bodily forms of the *Batwa* were well developed and entirely made the impression of normal

Mr Sidney Langford Hinde emphasizes their skill as bowmen and the deadliness of the poisoned arrows in use by the dwarfs while Mr Samuel Phillips Verner adds still further to our knowledge of their manner of life *It was Mr Verner who at the instigation of the Louisiana Purchase Exposition brought a group of Batwa* from the Congo Free State to St Louis His account of this drawfish race is to be found in an article published in the *Atlantic Monthly* for August 1902 and in his book entitled Pioneering in the Congo According to his information given by him the *Batwa* are fishermen as well hunt men they spread their nets both those for hunting and those for fishing upon poles under grass sheds their bows are of a crimson-colored wood strung with rattan fiber while their arrows are of bamboo notched at one end pointed at the other and coated with the black sticky gum which appears when the roots of a Euphorbia are boiled and pressed their food ranges from hippopotamus to white ant including locust caterpillars the ant dried in the sun besides all varieties of vegetable produce

With regard to their habit of hunting monkeys he tells how the *Batwa* clear half an acre of forest across which they stretch a net ten by forty feet and drive the monkeys from their haunts into the clearing dispatch them easily as they become enmeshed in the snare Baboon skins are prized for dress, or in the lack of this a yard of palm-fiber cloth Some women, however and the children, go unclad. Tattooing is not practised among them and beads, brass and copper wire are unknown, but gay feathers and amulets of bone or the skins of small animals are used for decorative purposes. The older men wear a scant beard. Such details of height and personal appearance as are cited by Mr Verner practically agree with those listed for all pygmies A *Bantu* proverb aptly illustrates their mental make up, "Sharp as a pygmy"

A recent visitor to the pygmy lands is Dr Frederick Starr whose paper upon the same people has but recently appeared among Ethnographic Notes from the Congo Free State: An African Miscellany' Dr Starr after a summary of the remarks of Wolf Hinde Bateman Stanley and Verner proceeds to report of his own contact with these little people that in addition to the numerous tables of measurements, deals with the structure of the *Batwa* huts, their ways of kindling fire by friction on wood and their custom of adorning the person by deeply cut and well marked temple scarring (of the matting or plaiting patterns)' and by clipping the teeth to blunt points Although at the commencement of his article Dr Starr owns to having expected to find in the *Batwa* typical pygmies" and to "have been in a confused frame of mind regarding them from first contact with them up till now and that What shall we do with the *Batwa* has been a harrassing question" he concludes "We believe that the *Batwa* should actually be classed with the true pygmies of the Ituri forest"—a statement strengthened by his elaborate comparison of a pygmy, a *dwarf* and a *Baluba* boy: "They are larger than we should like, but in type, face expression, character and mode of life, they are the same. Constancy of hunting, absence of agriculture, parasitic relation to large neighbors, shyness and distrust, despised condition, use of the bow and poisoned arrows, adherence to making fire by friction, all point one way To-day scattered and occurring here and there over a large area, they everywhere appear to have been the original occupants of the country'

One ethnologist divides the African negritos into three *branches upon his family tree of the Homo-Ethiopicus:* The *Akka* the *Wochua* and the *Batwa*—this last branching off into the *Obongo* on the one side and farther along into the fork of the *Hottentots* and the *Bushmen*. But a classification of this nature, even in the light of a review brief as the foregoing, can be seen to argue a somewhat strict division and subdivision not warranted by the information at hand The names, the number of races, if more than one, much less the course of development or branching of one tribe from another, is by no means clear as Keane's table would give us to understand *Certainly in view of the scarcity of actual scientific knowl*edge upon the subject, the attempt to prove that "all the tribes of Africa whose proper characteristic is an abnormally low stature belong to one and the self-same race" (Schweinfurth) *is of more consequence* than a hard-and-fast tabulation of tribes within that generalization of race

Prof. Van der Waals of Leyden

A Nobel Prize Winner

The eminent Dutch physicist Professor Van der Waals of Leyden who has just received one of the Nobel prizes is justly celebrated throughout Europe for his *contributions to the advancement of science* His name however is as yet little known in this country and this is the more strange because his fame largely rests upon his development and application of a scientific theory first promulgated by an American physicist W Gibbs

A writer in a recent number of *La Nature* gives an interesting *résumé* of Van der Waals achievements and their basis

Born at Leyden in 1835 he became celebrated upon the discovery of an equation which permits better than the *formula of Rankin and Hirn the expression of the char*acteristic relation of fluids i e the relation between specific volume pressure and temperature He has shown what expression should be substituted for each gas, in the laws of Mariotte and Gay Lussac when we endeavor to approximate reality To arrive at this he conceived the fecund idea of extending to gases the consideration upon which Laplace founded his theory of capillarity

The method adopted by the Dutch savant for governing the calculation and combining the results of diverse *investigation indicates a remarkable profundity of* thought; it is peculiarly attractive to those who study from the philosopher's point of view the genesis of the great theories of modern physics

Thanks to him the parallelism which has been observed in liquids with respect to certain special properties in definite conditions of temperature has taken on a general *character for all fluids whether liquid or gaseous* and a definite significance

Thus as Poincaré observes the Leyden physicist has given to the words corresponding states" a precise significance he has demonstrated that the specific constants of each body disappear in the characteristic equation when we take for units the values corresponding to critical points and that in corresponding states any two fluids have *precisely* the *same* properties

It may be remarked as was proved first by Natanson and afterwards by Prof Curie that the theory of corresponding states does not necessarily imply the exactitude of the formula of Van der Waals

But the last has not contented himself with studying the statics of a simple fluid He has regarded mixed fluids as *compositions of a vast number of particles* and has established an equation characteristic of mixtures which no longer depends on thermodynamic ideas as one might suppose but on mechanical hypotheses This equation has been made *the subject of a critical study by* Berthelot In short Van der Waals has extended his investigation to abnormal substances, associated or dissociated

One of his greatest services—a service both to science and to industry—was his appreciation and exploitation of the value of a remarkable treatise published in 1876 by *an* American physicist W Gibbs *on* The Equilibrium of Heterogeneous Substances"

This had remained practically ignored for fifteen years, until Van der Waals called the attention of the scientific world to it This *memoir* contained in practically complete form the theory of thermodynamic statics and the manifold applications of thermodynamics including notably the liquefaction of gases, are based on a profound study of this work

If certain biologic researches even lead to conclusions of the highest interest from the point of view of cosmogenic *hypotheses upon the cold of space* how many analogies in the immediate domain of applied science would be lacking if we were still ignorant of the famous law of phases and of the idea of eutexia thereto attached by Guthrie It is the application of this which permits the control and verification of complex facts such as the equilibrium between one or several bodies and the solution which contains them and, more generally which allows us to obtain a precise guide in critical investigations of chemical mechanics

These questions, apparently so theoretical are moreover of the greatest practical interest

Just as cryoscopic and tonometric measurements furnish to experimenters the easy solution of delicate problems of hygiene, such as the control of milk or other alimentary substances just as *isotonia* plays a more and more important part in medicine and physiology as is shown in the study of serums in the same way the law of phases facilitates the study of equilibriums in liquid or solid solutions such as the complex equilibrium between the salts of sea water the study of steels and metallic alloys, and the study of petroleums, glasses, cements and hydraulic mortars

If the physicist finds scientific interest of capital importance in the relation which defines the equilibrium of homogeneous gaseous systems, the engineer finds no less interest in the ability to obtain a precise knowledge of the phenomena of the reduction of minerals in gas furnaces

Finally the labors of Van der Waals have largely contributed to the establishment *of the fact of the existence* of a continuous passage of matter from the liquid to the gaseous state a point as important for the philosopher as for the scientist.

By his penetrating intellect his exact *reasoning* and his bold forecasts justified by later experiment Van der Waals has won a pre-eminent place among men of science The bestowal of the Nobel prize upon him will now make known to the enlightened public the name of this theorist whose investigations of the laws of kinetics have been so fertile in applications of industrial importance.

Resistance of Metallic Filament Lamps to Shock

The employment of metallic filament lamps is rapidly increasing because their consumption of electrical energy is only about one third that of carbon filament lamps of the same candle power while their price has fallen from 80 or 90 cents apiece to 40 or 50 cents The principal defect of metallic filaments is their fragility When cold they are easily broken by shock and vibration The filament itself is in less danger of breakage when heated by the current but then the same agencies often weld together filaments which are too slack or too near each other Hence the cost of renewal is large and these lamps cannot be used in railway or trolley cars, or in portable mountings

For these reasons it is important to determine the degree of sensitiveness to shock possessed by various metal lic filament lamps This has been done by suspending the lamp by a flexible wire and subjecting it to the impact of a rubber coated leaden bullet which rolls down an inclined track The force of the impact can be varied by varying the weight of the bullet and the length and inclination of the track

Dr F Lugrand has invented another apparatus for subjecting the filament to a series of shocks the intensity of which can be regulated The lamp is fastened on a board *AB* which turns on a hinge at *A* (Fig 1) The free end *B* of the board is alternately raised by the rotation of the spiral cam *c* and brought down again by the weight of the lamp and board assisted by the tension of the spring *R*

After falling through the distance *h* determined by the profile of the cam the board is suddenly arrested by striking the small part of the cam. The intensity of the shock which is thus given to the lamp is determined by the tension of the spring which can be varied and can be measured with a steel yard *In order to ascertain the* number of shocks that the filament can withstand before breaking an apparatus for counting the number of revolutions is attached to the shaft of the cam, which is turned by an electric motor at the rate of one revolution per second The key *ab* (Fig 2) in the circuit of the motor is kept closed while the lamp is burning by the relay *R*

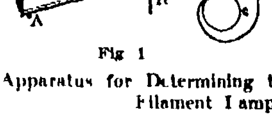

Fig 1

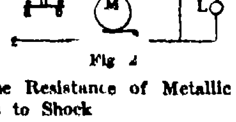

Fig 2

Apparatus for Determining the Resistance of Metallic Filament Lamps to Shock

which is traversed by the lamp current. When the filament breaks the key is opened by a spring, the motor stops and the number of shocks which the lamp has received is indicated by the registering apparatus In measuring the ability of the filament to resist shock when cold the lamp circuit is closed during only a small fraction of each second, by means of rotary commutator *C* keyed on the shaft of the cam The intermittent current thus produced does not greatly heat the filament, but it keeps the motor circuit closed by means of the relay until the filament breaks The number of shocks required to weld two heated filaments together can be determined by adjusting the relay so that it opens the motor circuit when the resistance of the lamp has been diminished by a certain amount of welding of the filaments.—*Le Génie Civil.*

Invar Wires for Geodesic Work

Wires of the new non-expansion alloy known as invar have been used for measuring in geodesic work in the Simplon Tunnel and in various scientific expeditions It is valuable for such uses as it keeps its length to a very close degree This metal it will be remembered is a nickel steel alloy with about 34 per cent nickel, and it expands but 1 10 the amount for iron hence it is coming into use for scientific work M C Guillaume, chief of the Weights and Measures Bureau of Paris, who prepared this alloy made tests with measuring wires in the basement of the establishment As a base he used lines drawn on nickel plates incrusted in heavy bronze soles, and these were cemented into the foundation walls, using six measuring marks at 19 feet apart, covering 79 feet of length He compared the measuring wires directly with this standard, stretching them by heavy weights and pulleys The wires carry measuring scales attached to their ends. Twelve wires gave almost identical lengths for some years, and any irregularities were found to be mainly due to the expansion of the wall itself. Several years observations allowed of establishing the variations of the wall, which were about two-thirds that of the wires. The wires do not vary at constan temperature, more than one-millionth, so that "invar" can be quite depended on. He also caused the wires to be expanded with heat up to about 40 degrees change and found that the expansion was very regular and there were no sudden changes A weight of about 90 pounds was used for stretching Before this, M Jäderin brought out a geodesic method using a steel and brass wire. The temperature was deduced from the difference of length, and we thence find the real length. By using invar we need but one wire and use but a rough estimate of the temperature.

Migrating Stars*

Old and New Star-Drift Theories

By J A Hardcastle, F R A S

The great doctrine of the Fixity of the Stars, has without question exerted a profound influence for good over the imagination of the human race, and the critic who casts it aside as merely an obsolete error only proves his own incapacity for criticism New conceptions of the stellar universe have arisen to replace it and will doubtless in their turn elevate the responsive mind, but the new must be built on the old or to use a truer metaphor the new must grow out of the old for intellectual change is no less organic than is our physical growth From the ancient doctrine of the incorruptibility of the heavens has sprung our own implicit acceptance of the Continuity of Nature that is to say, the permanence of what we call the Laws of Nature We need not fear to cast our imagination far into the future and contemplate the possibility of our present views undergoing as radical a change as has been the fate of the Fixity of the Stars, though we may not at present be able to suspect from what direction the new knowledge will come

It requires therefore no defence if we start with the statement that all the stars are moving we need not rely simply on the *a priori* inconceivability of the contrary, we have the observed fact that the angular distance between any pair of stars is not now the same as it was in the days of Bradley Nor need we here emphasize the great difficulty of grasping the precise meaning of the words Proper Motion but it will be obvious that any vagueness as to the technical contents of that phrase will tend to obscure our judgment when we discuss the indications of a sympathetic distribution of proper motions

These indications were first brought to light by Proctor[1] nearly forty years ago and to him we owe the origin of the expression "star drifts He showed that large groups of stars were animated by a motion across the sky in the same direction and at the same rate and we must admit the cogency of his argument that this cannot be regarded as accidental It is in fact, the fulfillment of the conjecture thrown out a century earlier by William Herschel in "The Philosophical Transactions" of 1783 in a paper entitled On the Proper Motion of the Sun etc The very title of that paper is [a] tification of the word of warning we have just uttered as to the difficulty of keeping quite clear the meaning of the term Proper Motion Even in a modern syllabus we have the expression The Proper Motion of the Sun used to describe its apparent annual motion among the stars so it is little wonder if the term Proper Motion is a stumbling block to many a beginner We may perhaps state here once for all that the Proper Motion of a star is the minute change of the *apparent* position which it occupies *with reference to the other stars* it would require too much space were we to attempt to bring out the full meaning of the words placed in italics

Proctor's word "drift has recently been appropriated to a far larger process of which he had no means of knowing The story of Kapteyn's "Two-Drift Theory" does not enter into the scope of this article, and we need some word which we can use for the much more limited groups to which we now refer By a happy inspiration Prof Turner has given them the name of "Migrating Stars [2] the various flocks of which need not, of course be moving in the same direction but the individual members of each flock will be distinguished by the fact that their motions are parallel and equal Some of the members of a flock may have passed us some may be passing on the right some on the left, while some are still approaching us Thus we may have to look to all points of the heavens to pick out the components of any one flock

'Parallelism and equality of motion are Proctor's words, and we shall presently see how the investigation has carried us now to a point where both those features vanish, and yet the main idea not only remains true but is vastly enlarged This is only one more instance of the growth of ideas the very characteristics by which originally they were defined are discarded and yet the idea remains

The best known cases of equal parallel motion are perhaps the Pleiades and the Great Bear The arrows in Fig 1 give by their length and direction the most recent values of the proper motions of those stars. Proctor's discovery is seen at a glance.

Five out of seven are moving in a common progress; the other two obviously do not belong to them In Fig. 2 we have the arrangement as it will be in 100,000 years, as seen by an observer in the solar system It may justly be urged with regard to Fig 2 that we are multiplying observed quantities by at least 1,000, and consequently their errors too The thousandth part of the length of one of the arrows is a mere point, the uncertainty then *of the direction* of that fraction must surely be very great. The criticism is unquestionably reasonable, and we cannot give the space now to meet it, but we can only state that not only is Fig 2 accepted by men who are competent to judge of the evidence, but also the much wider inferences to which we shall presently refer are considered sound by leading authorities

Before continuing the story of these five stars we will describe another flock of migrants detected by Prof Lewis Boss in the constellation of Taurus[3] Prof Boss of Albany will be remembered in the annals of astronomy "for his long-continued work on the positions and proper motions of fundamental stars,' to quote the words in which the award of the Gold Medal of the Royal Astronomical Society was made to him in 1905 One of the by products of his exhaustive and accurate work which by the way, was undertaken in order to stake out the 49th parallel of latitude as the boundary between Canada and the United States, was the detection of

Figs 1 and 2 are drawn from modern values of the proper star motions Fig 1 shows the equal parallel movement of five out of seven stars in a common progress the divergent stars not belonging to the flock Fig 2 shows the arrangement as it will be seen by an observer in the solar system in 100 000 years

the fact that 39 stars in Taurus have proper motions directed toward one spot on the celestial sphere He gave the name "the convergent for this point and it will be readily admitted that it must be the vanishing point of a sheaf of parallel tracks In this case the component stars are scattered over a circular region of the sky so large that six out of the seven stars of the Great Bear could lie on it As a cluster therefore those 39 stars are extremely loose and in no way catch the eye the individuals being quite faint stars Let the imagination however be projected forward some sixty million years and the convergence of the tracks will *have brought them all on to a smaller space than is* now occupied by the Pleiades If then the cluster will thus condense by mere perspective and the lapse of time may we not argue backwards and suggest that the compact clusters which we now see might have appeared many million years ago as mere scattered stars apparently quite dissociated and may we go on to suspect that the actual distances between components of a star cluster may be comparable to the distance which separates us from the nearest of our stellar neighbors To have written such words a couple of years ago would have laid one open to the charge of indulging in unguided speculation; this single group of stars has very

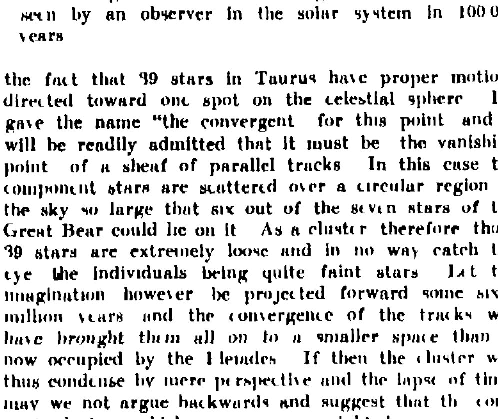

Fig 3 shows a diagram of a cube in perspective with the vanishing point Fig 4 diagram to aid in finding proper motion of star its velocity and distance

greatly widened the limits within which our imaginations may safely play

In this case, therefore the parallelism of Proctor's arrows has given place to a convergence of the apparent motions But the essential feature of parallel motion does not disappear; it is, in fact, brought out more strikingly, and a perspective is added which immensely increases the picturesqueness of the whole conception The impression that the starry sky is a mere shell or vault is only too easily forced upon us, but here we have a third dimension the depth of space illustrated vividly before our imagination

In Fig 3, which is the sketch of a cube in perspective with the vanishing point O of three edges shown we know that any other line parallel to those edges must, if produced go through O and for an inverse reason the line of sight from the observer's eye to O must be parallel to those edges

If then one looks at the vanishing point one is looking in a direction parallel to the lines that there vanish When shafts of light are seen radiating from the sun, we know that they are really all parallel and their common direction is given us by the line from our eye to the sun although it must be frankly admitted that it requires a real control over the imagination to make it assent to this unimpeachable truth Now the point O corresponds to "the convergent of Boss's cluster but supposing all his proper motions had been on the same lines but in the opposite direction then we should have to call O the divergent and the convergent will be in the diametrically opposite direction from O Suppose a rod pointing at O and suppose we look the other way along it our line of sight would be parallel still to the motions of the stars and we should be looking at "the convergent' We shall have to use this little *proposition in our next example of a flock of migrating stars*

Returning once more to Proctor's five stars his information only warranted him in asserting that the arrows were sensibly parallel the more precise determinations made by Dr Ludendorff from recent catalogues show us that those arrows are not parallel but the arrangement is only the more remarkable for they all diverge with extraordinary accuracy from a single spot at R A 123 deg Dec 37 deg N One might be tempted at first to exclaim that Proctor's whole foundation was obviously rotten if once parallelism is disproved it was pure luck that led him to associate these five stars and Fig 2 must also be unreliable And yet as a matter of fact we have drawn both in Fig 1 and Fig 2 from these modern values of the proper motions The divergent happens to be placed precisely on the line that so nearly passes through ζ ϵ δ and β at a distance to the right of β equal to twice the distance from δ to β We will call the divergent D and its antipodes which is therefore the convergent shall be C It is easy to picture these two points to oneself on the sky if one recalls the appearance of the Great Bear on a September evening lying in the northwest about as shown in Fig 1 D will then be the actual north point of the horizon and C will be the exact south point of the horizon (speaking for an observer in latitude 53 deg N) Accordingly at such a moment a rod placed horizontally north and south gives us *completely* the direction of the motion of this flock of stars past us Each arrow on the sky vault, giving a proper motion only indicates *partially* the direction of flight but if we may assume that the convergence means parallelism in perspective then we know from the convergent the *complete* motion relative to ourselves

Returning to the actual sky on the September evening at Sid time 20 hours i e about 8 P M on the 21st suppose we hold a square card with one edge horizontally north and south and tilt the west side up about 30 deg we shall find we can draw lines on it which will point quite straight to β δ ϵ and Ursæ Majoris (γ will be a little below the plane) and we will select β *for the moment to represent the group Let ON Fig* 4 be the edge of the card pointing horizontally north and Ou be directed to β The angle NOu will be 29 deg Then taking u anywhere on this line u can represent the star β and a line TC drawn parallel to NO represents the direction of β motion because it is pointing at C the "convergent or vanishing point For the present we know nothing about the magnitude of this motion in miles per second but let us take a length uc to represent this unknown velocity and we can split it up by the usual methods into ub perpendicular to uO and ua along uO

We must not say that ub is the proper motion of the star because proper motion is an angle and ub in our diagram is a distance but they are related by the fact that ub equals the angular motion multiplied by O the distance of the star

Now the distance of none of these stars is known and it is an interesting fact that from the detection of their convergent motion we can deduce their distance for we shall presently see that we can calculate the value of ub and we know of course the angular motion In the case of β this is 8 7 sec per century

Pass now to the components Ua which is the radial or line of sight motion of the star Dr Ludendorff has elaborately discussed this question which is extremely difficult for reasons which we must pass over For β he obtains the value 16 8 kilometers which means an approach of 10½ miles per second We may therefore say that ua 10½, and since the angle $Cua = NOu$ 29 deg we can deduce that $uc = 11½$ and we have at once the velocity of progress of the whole system it is 11½ miles per second Now we can go on to compute ub which must be 11½ cos 61 deg = 5½ and a little arithmetic will show that if β moves 8 7 seconds per century and this is really 5½ miles per second β must be about 400 billion miles away this would mean a parallax of about 0 05 second which is by no means unreasonable It may be of interest to remark that according to Prof Kapteyn's statistical estimates a star of the magnitude of β with a proper motion comparable to that of β might be expected to have a parallax of 0 025 second This may be regarded as quite a fair agreement

So far we have spoken only of β; it will be well to

* Knowledge and Scientific News

[1] Proc. R. S., vol. xviii, p. 169, and 'Other Worlds Than Ours," p. 86.

[2] "Knowledge Review," January, 1910.

[3] Astr Journal, No. 604.

have it clear what quantities we demand from the other stars if they are accepted as parts of the same flock

(1) Their proper motions must diverge from D—or converge on C

(2) Any known facts about their distance, radial motion, and amount of proper motion must fit in with the assumption that the velocity of the flock is 11½ miles per second. It is extremely unfortunate that for these stars the radial velocities are difficult to ascertain because they appear to be variable. Dr Ludendorff establishes β as a spectroscopic Binary and satisfies himself that ε is so too while ζ has long been so recognized. He obtains for ε and ζ the radial velocities — 13 and 12.6 kilometers (8.08 and 7.83 miles). If they belong to the flock those quantities should be 18.9 and — 18.9 (8.20 and 7.58) so this is a fairly strong corroboration but the main strength of the argument in favor of these five forming a flock is the convergence of their directions of proper motion, and their general similarity of magnitude and spectrum and possible duplicity.

We now come to a very pleasing development of this research. Dr Hertzsprung has sought for other possible members of this flock not confining his scrutiny to the immediate neighborhood of Ursa Major. The two criteria above mentioned were his guides the former of the two being naturally first applied. He found six stars whose motion fairly well converged on the point C R A 303 deg Dec -37 deg and one would naturally expect that some such result would emerge in reviewing any extensive list of stars. We must not then give much weight to the possible connection unless the second criterion is also satisfied.

Now the only star among the six for which we have the necessary information as to radial velocity and distance is Sirius, and the fact that the evidence is entirely satisfactory will be an exceptionally popular addition to stellar astronomy.

In the first place, the arrow of Sirius's proper motion is directed nearly precisely to the point C, and since the length of that arrow is ten times as great as any of Proctor's five stars it affords to that extent a more delicate test. Then the parallax of Sirius is well determined, the Nautical Almanac only recognises officially three parallaxes—those of Sirius and Centauri, and 61 Cygni, giving that of Sirius the value of 0.37 second. The radial velocity of Sirius has known many vicissitudes, and is at present accepted as —7.4 kilometers that is to say the Sirian system is approaching us at 4.6 miles per second.

On the September evenings, when C and D are so conveniently placed on our horizon, Sirius is not far from the Nadir; but without troubling to give the steps of computation it will suffice to state that the second criterion would demand from Sirius the following qualifications:

Parallax should be	0.387";	it is 0.37"
Radial velocity should be	—8.5;	it is —7.4

This second justifies us in stating with confidence that Sirius belongs to the same flock as Proctor's five stars, and Mr Eddington has remarked: "It would have been an interesting theme for the classical mythologists to explain how so important a part of the Great Bear has come to be situated between the teeth of the Great Dog."

There are two further striking inferences to be made from the distances which this discussion discloses. The actual stars of the Great Bear must be from 30 to 130 times as luminous as our sun—which places them, according to Kapteyn's estimates, among the larger of the heavenly bodies, for he only admits about 12 per cent. of the stars to be intrinsically more luminous than the sun. And, secondly, this stream, the existence of which is now accepted, comprises within its limits stars separated from each other by distances up to 30 light-years, say 600 billions of miles.

We pointed out at the beginning of this article that the doctrine of the Fixity of the Stars, immeasurable though its value has been, must now be abandoned, but we may begin to see that its place will be filled by another conception no less stimulating. In the place of the incorruptible crystalline sphere with its fixed stars we have opening gradually before us the appalling picture of the immensity of the universe. The utilitarian who points to navigation and to frontier-staking as the uses of astronomy merely convicts himself of being a shallow philosopher.

Making Money Out of Bees—III*

Keeping Bees for Pleasure and Profit

By E F Phillips, Ph D, in charge of Bee Culture, Bureau of Entomology

Concluded from Supplement No 1834, page 126

PREPARATION FOR THE HARVEST

An essential in honey production is to have the hive overflowing with bees at the beginning of the honey flow so that the field force will be large enough to gather more honey than the bees need for their own use. To accomplish this the bee keeper must see to it that brood rearing is heavy some time before the harvest and he must know accurately when the honey flows come so that he may time his manipulations properly. Brood rearing during the honey flow usually produces bees which consume stores while brood reared before the flow furnishes the surplus gatherers. The best methods of procedure may be illustrated by giving as an example the conditions in the white-clover region.

In the spring the bees gather pollen and nectar from various early flowers and often a considerable quantity from fruit bloom and dandelions. During this time brood rearing is stimulated by the new honey but afterwards there is usually a period of drought when brood rearing is normally diminished or not still more increased as it should be. This condition continues until the white clover flow comes on usually with a rush when brood rearing is again augmented. If such a condition exists the bee keeper should keep brood rearing at a maximum by stimulative feeding during the drought. When white clover comes in bloom he may even find it desirable to

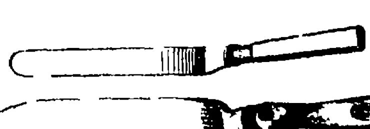

Fig 18 Knives for Uncapping Honey

prevent brood rearing to turn the attention of his bees to gathering.

A worker bee emerges from its cell twenty-one days after the egg is laid and it usually begins field work in from fourteen to seventeen days later. It is evident therefore, that an egg must be laid five weeks before the honey flow to produce a gatherer. Since the flow continues for some time and since bees often go to the field earlier than fourteen days, egg laying should be pushed up to within two or three weeks of the opening of the honey flow. In addition to stimulative feeding, the care of the colony described under the heading of Spring management will increase brood production.

THE PRODUCTION OF HONEY

The obtaining of honey from bees is generally the primary object of their culture. Bees gather nectar to make into honey for their own use as food but generally store more than they need, and this surplus the bee keeper takes away. By managing colonies early in the spring as previously described, the surplus may be considerably increased. The secret of maximum crops is to "Keep all colonies strong."

Honey is gathered in the form of nectar secreted by various flowers, transformed by the bees, and stored in the comb. Bees also often gather a sweet liquid called "honeydew," produced by various scale insects and plant lice, but the honeydew honey made from it is quite unlike floral honey and should not be sold for honey. It is usually unpalatable and should never be used as winter food for bees. When nectar or honeydew has been thickened by evaporation and otherwise changed the honey is sealed in the cells with cappings of beeswax.

It is not profitable to cultivate any plant solely for the nectar which it will produce but various plants, such as clovers alfalfa and buckwheat are excellent honey plants

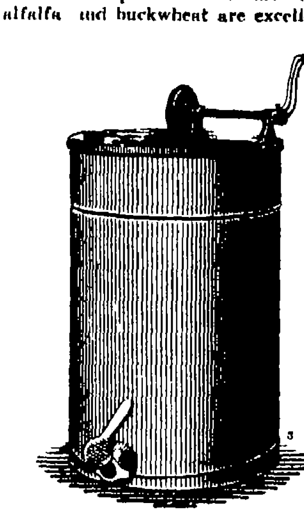

Fig 19—Honey Extractor

as well as valuable for other purposes. Their cultivation is therefore a benefit to the bee keeper. It is often profitable to sow some plant on waste land; sweet clovers are often used in this way. The majority of honey-producing plants are wild and the bee keeper must largely accept the locality as he finds it and manage his apiary

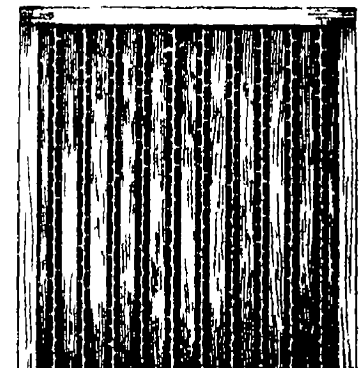

Fig 20—Perforated Zinc Queen Excluder

so as to get the largest possible amount of the available nectar. Since bees often fly as far as two or three miles to obtain nectar, it is obvious that the bee keeper can rarely influence the nectar supply appreciably.

EXTRACTED HONEY

Extracted honey is honey which has been removed by means of centrifugal force from the combs in which the bees stored it. In providing combs for the storage of honey to be extracted the usual practice is to add to the top of the brood chamber one or more hive bodies just like the one in which brood is reared and fill these with frames. If preferred, shallower frames with bodies of proper size may be used, but most honey extractors are made for full size frames. The surplus bodies should be put on in plenty of time to prevent the crowding of the brood chamber and also to act as a preventive of swarming.

Honey for extracting should not be removed until it is well ripened and a large percentage of it capped. It is best, however, to remove the crop from each honey flow before another heavy producing plant comes into bloom, so that the different grades of honey may be kept separate.

The frames containing honey to be extracted are removed from the hive, the cappings cut off with a sharp, warm knife (Fig 18) made specially for this purpose, and the frames are then put into the baskets of the honey extractor (Fig 19). By revolving these rapidly the honey is thrown out of one side. The basket is then reversed

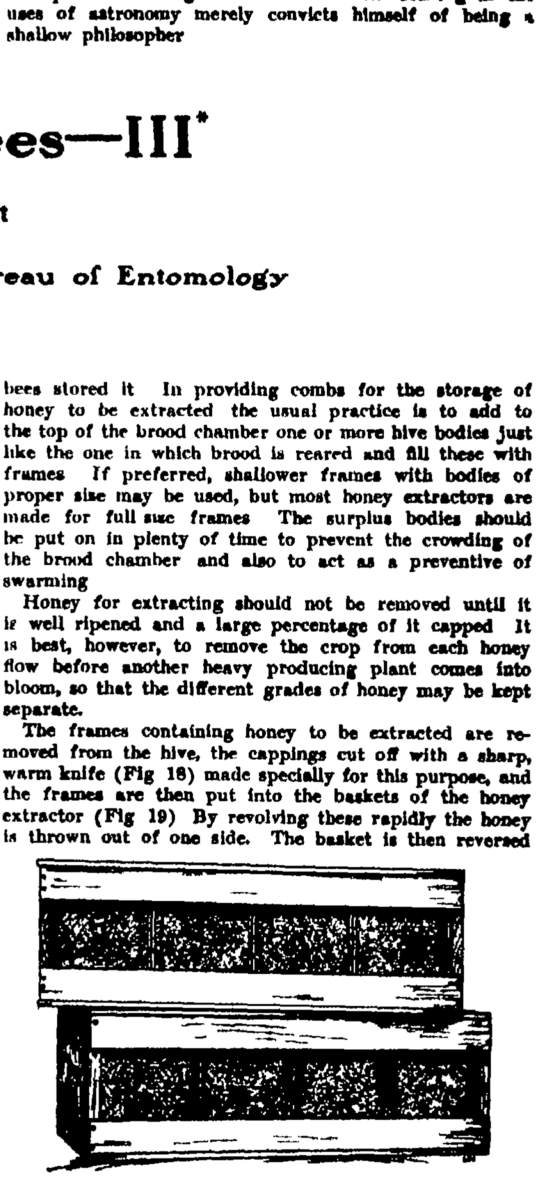

Fig 21—Shipping Cases for Comb Honey

and the honey from the other side is removed. The combs can then be returned to the bees to be refilled, or if the honey flow is over, they can be returned to the bees to be cleaned and then removed and stored until needed again. This method is much to be preferred to mashing the comb and straining out the honey, as was formerly done.

The extracted honey is then strained and run into vessels. It is advisable not to put it in bottles at once, but to let it settle in open vessels for a time, so that it can be skimmed. Most honeys will granulate and become quite hard if exposed to changes of temperature, and to liquefy granulated extracted honey it should be heated in a water bath. Never heat honey directly over a stove or flame, as the flavor is thereby injured. The honey should never be heated higher than 160 deg F, unless it is necessary to sterilize it because of contamination of disease.

Extracted honey is put up in bottles or small tin cans for the retail trade, and in 5-gallon square tin cans or barrels for the wholesale market. Great care must be exercised if barrels are used, as honey will absorb moisture from the wood, if any is present, and cause leakage. The tin package is much to be preferred in most cases. In bottling honey for retail trade, it will well repay the bee keeper or bottler to go to considerable expense and trouble to make an attractive package, as the increased price obtained will more than make it up. Honey should be heated to 160 deg. F., and kept there for a time before

*Farmers Bulletin No 397 U S Department of Agriculture.

bottling, and the bottle should be packed as full as possible and sealed hermetically.*

COMB HONEY

Comb honey is honey as stored in the comb by the bees, the size and shape being determined by the small wooden sections provided by the bee keeper. Instead of having comb in large frames in which to store surplus honey, the bees are compelled to build comb in the sections and to store honey there (Fig 2). A full section weighs about 1 pound; larger ones are rarely used. By the use of modern sections and foundation the comb honey now produced is a truly beautiful, very uniform product—so uniform in fact that it is often charged that it must be artificially manufactured. The purchaser of a section of comb honey may be absolutely certain, however, that he is obtaining a product of the bees, for never has anyone been able to imitate their work successfully. To show their confidence in the purity of comb honey, the National Bee Keepers Association offers $1 000 for a single pound of artificial comb filled with an artificially prepared sirup.

There are several different styles of sections now in use, the usual sizes being 4¼ inches square and 4 inches by 5 inches. There are also two methods of spacing so that there will be room for the passage of bees from the brood chamber into the sections and from one super of sections to another. This is done either by cutting "bee ways" in the sides of the sections and using plain flat separators or by using "no bee-way" or plain sections and using "fences"—separators with cleats fastened on each side, to provide the bee space. To describe all the different supers or bodies for holding sections would be impossible in a bulletin of this size, and the reader must be referred to catalogues of dealers in bee-keeping supplies. Instead of using regular comb-honey supers some bee keepers use wide frames to hold two tiers of sections. It is better, however to have the supers smaller so that the bees may be crowded more to produce full sections. To overcome this difficulty shallow wide frames holding one tier of sections may be used. The majority of bee keepers find it advisable to use special comb-honey supers.

In producing comb honey it is even more necessary to know the plants which produce surplus honey and just when they come in bloom than it is in extracted honey production. The colony should be so manipulated that the maximum field force is ready for the beginning of the flow. This requires care in spring management, and above all the prevention of swarming. Supers should be put on just before the heavy flow begins. A good indication of the need of supers is the whitening of the brood combs at the top. If the bees are in two-hive bodies they should generally be reduced to one, and the frames should be filled with brood and honey so that as the new crop comes in the bees will carry it immediately to the sections. If large hives are used for the brood chamber it is often advisable to remove some of the frames and use a division board to crowd the bees above. To prevent the queen from going into the sections to lay, a sheet of perforated zinc (Fig 20) may be put between the brood chamber and the super (Fig 2).

It is often difficult to get bees to begin work in the small sections, but this should be brought about as soon as possible to prevent loss of honey. If there are at hand some sections which have been partly drawn the previous year these may be put in the super with the new sections as bait. Another good plan is to put a shallow extracting frame on either side of the sections. If a few colonies in the apiary that are strong enough to go above still refuse, lift supers from some colonies that have started to work above and give them to the slow colonies. The super should generally be shaded somewhat to keep it from getting too hot. Artificial swarming will quickly force bees into the supers.

To produce the finest quality of comb honey full sheets of foundation should be used in the sections. Some bee keepers use nearly a full sheet hung from the top of the section and a narrow bottom starter. The use of foundation of worker-cell size is much preferred.

When one super becomes half full or more and there are indications that there will be honey enough to fill others the first one should be raised and an empty one put on the hive under it. This tiering up can be continued as long as necessary but it is advisable to remove filled sections as soon as possible after they are nicely capped, for they soon become discolored and less attractive. Honey removed immediately after capping finds a better market, but if left on the hive even until the end of the summer the quality of the honey is improved. A careful watch must be kept on the honey flow so as to give the bees only enough sections to store the crop. If this is not done a lot of unfinished sections will be left at the end of the flow. Honeys from different sources should never be mixed in the sections, as it gives the comb a bad appearance.

To remove bees from sections, the super may be put over a bee escape so that the bees can pass down but can not return, or the supers may be removed and covered with a wire-cloth-cone bee escape.

After sections are removed the wood should be scraped free of propolis (bee glue) and then packed in shipping cases (Fig 21) for the market. Shipping cases to hold 12, 24 or 48 sections, in which the various styles of sections fit exactly, are manufactured by dealers in supplies. In shipping these cases, several of them should be put in a box or crate packed in straw and paper and handles provided to reduce the chances of breakage. When loaded in a freight car the combs should be parallel with the length of the car.

In preparing comb honey for market it should be carefully graded so that the sections in each shipping case are as uniform as possible. Nothing will more likely cause wholesale purchasers to cut the price than to find the first row of sections in a case fancy and those behind of inferior grade. Grading rules have been adopted by various bee keepers' associations or drawn up by honey dealers. The following set of rules are in general use:

Eastern Grading Rules for Comb Honey

Fancy. All sections well filled, combs straight, firmly attached to all four sides, the combs unsoiled by travel stain or otherwise; all the cells sealed except an occasional one; the outside surface of the wood well scraped of propolis.

A No 1. All sections well filled except the row of cells next to the wood; combs straight; one eighth part of comb surface soiled, or the entire surface slightly soiled; the outside surface of the wood well scraped of propolis.

No 1. All sections well filled except the row of cells next to the wood; combs comparatively even; one eighth part of comb surface soiled, or the entire surface slightly soiled.

No 2.—Three fourths of the total surface must be filled and sealed.

No 3.—Must weigh at least half as much as a full weight section.

In addition to this the honey is to be classified according to color, using the terms white, amber and dark; that is, there will be Fancy White, No 1 Dark, etc.

New Comb Honey Grading Rules Adopted by the Colorado State Bee Keepers Association

No 1 White. Sections to be well filled and evenly capped except the outside row next to the wood; honey white or slightly amber; comb and cappings white and not projecting beyond the wood; wood to be well cleaned; cases of separatored honey to average 21 pounds net per case of 24 sections; no section in this grade to weigh less than 13½ ounces. Cases of half separatored honey to average not less than 22 pounds net per case of 24 sections. Cases of unseparatored honey to average not less than 23 pounds net per case of 24 sections.

No 2 Light Amber.—Sections to be well filled and evenly capped, except the outside row next to the wood; honey white or light amber; comb and cappings from white to off color, but not dark; comb not projecting beyond the wood; wood to be well cleaned. Cases of

Fig. 41. A PENNSYLVANIA APIARY

REMOVING A BEE THAT HAS STUNG THE BEE KEEPER

A BEE COLONY ON THE ROOF OF A HOUSE

A QUICK DOWNWARD JERK PRECIPITATES THE BEES ON THE ROOF

*For further discussion of the production and care of extracted honey, see Bulletin 75, Part I, Bureau of Entomology. It may be obtained from the Superintendent of Documents, Washington, D. C. Price 5c.

separatored honey to average 21 pounds net per case of 24 sections no section in this grade to weigh less than 13½ ounces Cases of half separatored honey to average not less than 22 pounds net per case of 24 sections Cases of unseparatored honey to average not less than 23 pounds net per case of 24 sections

No. 3 This includes all white honey and amber honey not included in the above grades sections to be fairly well filled and capped no more than 25 uncapped cells exclusive of outside row permitted in this grade wood to be well cleaned no section in this grade to weigh less than 12 ounces Cases of separatored honey to average not less than 19 pounds net Cases of half separatored honey to average not less than 20 pounds net per case of 24 sections Cases of unseparatored honey to average not less than 21 pounds net per case of 24 sections

THE PRODUCTION OF WAX

Beeswax which is secreted by the bees and used by them for building their combs is an important commercial product There are times in almost every apiary when there are combs to be melted up, and it pays to take care of even scraps of comb and the cappings taken off in extracting A common method of taking out the wax is to melt the combs in a solar wax extractor This is perhaps the most feasible method where little wax is produced but considerable wax still remains in old brood combs after such heating Various wax presses are on the market or one can be made at home If much wax is produced the bee keeper should make a careful study of the methods of wax extraction as there is usually much wax wasted even after pressing

PREPARATIONS FOR WINTERING

After the main honey flow is over the management must depend on what may be expected later in the season from minor honey flows If no crop is to be expected the colony may well be kept only moderately strong so that there will not be so many consumers in the hive

In localities where winters are severe and breeding is suspended for several months great care should be taken that brood rearing is rather active during the late summer so that the colony may go into winter with plenty of young bees In case any queens show lack of vitality they should be replaced early so that the bees will not become queenless during the winter

The important considerations in wintering are plenty of young bees a good queen plenty of stores of good quality sound hives and proper protection from cold and dampness

If as cold weather approaches the bees do not have stores enough they must be fed Every colony should have from 25 to 50 pounds depending on the length of winter and the methods of wintering It is better to have too much honey than not enough for what is left is good next season If feeding is practiced honey may be used but sirup made of granulated sugar is just as good and is perfectly safe If honey is purchased for feeding great care should be taken that it comes from a healthy apiary otherwise the apiary may be ruined by disease *Never feed honey bought on the open market* The bees should be provided with stores early enough so that it will not be necessary to feed or to open the colonies after cold weather comes on Honeydew honey should not be left in the hives as it produces dysentery" Some honeys are also not ideal for winter stores. Those which show a high percentage of gums (most tree honeys) are not so desirable but will usually cause no trouble

In wintering out of doors the amount of protection depends on the severity of the winter In the South no packing is necessary and even in very cold climates good colonies with plenty of stores can often pass the winter with little protection but packing and protection make it necessary for the bees to generate less heat and consequently they consume less stores and their vitality is not reduced Dampness is probably harder for bees to withstand than cold and when it is considered that bees give off considerable moisture precautions should be taken that as it condenses it does not get on the cluster An opening at the top would allow the moisture to pass out but it would also waste heat so it is better to put a mat of burlap or other absorbent material on top of the frames The hive may also be packed in chaff leaves, or other similar dry material to keep out the cold Some hives are made with double walls the space being filled with chaff these are good for outdoor wintering The hive entrance should be lower than any other part of the hive so that any condensed moisture may run out The hives should be sound and the covers tight and waterproof

Entrances should be contracted in cold weather not only to keep out cold wind but to prevent mice from entering There should always be enough room, however for bees to pass in and out if warmer weather permits a flight

In the hands of experienced bee keepers cellar wintering is very successful but this method requires careful study The cellar must be dry and so protected that the temperature never varies more than from 40 to 45 deg F 43 deg F seems to be the optimum temperature The ventilation must be good or the bees become fretful Light should not be admitted to the cellar and consequently some means of indirect ventilation is necessary

Cellar wintering requires the consumption of less honey to maintain the proper temperature in the cluster and is therefore economical Bees so wintered do not have an opportunity for a cleansing flight often for several months but the low consumption makes this less necessary Some bee keepers advocate carrying the colonies out a few times on warm days, but it is not fully established whether this is entirely beneficial and is usually not practiced

The time for putting colonies in the cellar is a point of dispute, and practice in this regard varies considerably They should certainly be put in before the weather becomes severe and as soon as they have ceased brood rearing The time chosen may be at night when they are all in the hive, or on some chilly day

The hives may be piled one on top of the other, the lower tier raised a little from the floor The entrances should not be contracted unless the colony is comparatively weak It is usually not considered good policy to close the entrances with wire cloth, as the dead bees which accumulate more or less on the bottom board may cut off ventilation, and the entrance should be free so that these may be cleaned out

The time of removing bees from the cellar is less easily determined than that of putting them in. The colonies may be removed early and wraped in *black* tar paper or left until the weather is settled. If the weather is very warm and the bees become fretful, the cellar must either be cooled or the bees removed. Some bee keepers prefer to remove bees at night, so that they can recover from the excitement and fly from the hive normally in the morning One of the chief difficulties is to prevent the bees from getting into the wrong hives after their first flights They often "drift" badly with the wind, and sometimes an outside row will become abnormally strong, leaving other colonies weak

DISEASES AND ENEMIES.

There are two infectious diseases of the brood of bees which cause great losses to the bee-keeping industry of the United States These are known as American foul brood and European foul brood Both of these diseases destroy colonies by killing the brood, so that there are not enough young bees emerging to take the place of the old adult bees as these die from natural causes The adult bees are not attacked by either disease. In the hands of careful bee keepers both diseases may be controlled and this requires careful study and constant watching In view of the fact that these diseases are now widely distributed throughout the United States, every bee keeper should read the available literature on the subject, so that if disease enters his apiary he may be able to recognize it before it gets a start The symptoms and the treatment recommended by this Department are given in another publication which will be sent free on request.

It is difficult for a bee keeper to keep his apiary free from disease if others about him have diseased colonies which are not properly treated The only way to keep disease under control is for the bee keepers in the neighborhood to cooperate in doing everything possible to stamp out disease as soon as it appears in a single colony The progressive bee keeper who learns of disease in his neighborhood should see to it that the other bee keepers around him are supplied with literature describing symptoms and treatment, and should also try to induce them to unite in eradicating the malady Since it is so often impossible to get all the bee keepers in a community to treat infected colonies properly and promptly, it is desirable that the States pass laws providing for the inspection of apiaries and granting to the inspector the power to compel negligent bee keepers to treat diseased colonies so that the property of others may not be endangered and destroyed This has been done in a number of States, but there are still some where the need is great and in which no such provision has been made When no inspection is provided bee keepers should unite in asking for such protection so that the danger to the industry may be lessened

In case there is an inspector for the State or county he should be notified as soon as disease is suspected in the neighborhood Some bee keepers hesitate to report disease through fear that the inspector will destroy their bees or because they feel that it is a disgrace to have disease in the apiary There is no disgrace in having colonies become diseased, the discredit is in not treating them promptly The inspectors are usually if not universally good practical bee keepers who from a wide experience are able to tell what should be done in individual cases to give the best results with the least cost in material and labor They do not destroy colonies needlessly and, in fact, they all advocate and teach treatment

The brood diseases are frequently introduced into a locality by the shipping in of diseased colonies or more often the bees get honey from infected colonies, which is fed to them, or which they rob from discarded honey cans It is decidedly dangerous to purchase honey on the market, with no knowledge of its source, to be used in feeding bees. Many outbreaks of disease can be traced to this practice. It is difficult to prevent bees from getting contaminated honey accidentally If colonies are purchased, great care should be taken that there is no disease present Whenever possible, colonies should be purchased near at home, unless disease is already present in the neighborhood

There are other diseased conditions of the brood known to bee keepers as pickled brood but these can usually be distinguished from the two diseases previously mentioned The so-called "pickled brood" is not contagious and no treatment is necessary Bees also suffer from "dysentery," which is discussed in the earlier part of this bulletin and from the so-called "paralysis," a disease of adult bees. No treatment for the latter disease can as yet be recommended as reliable The sprinkling of powdered sulphur on the top bars of frames or at the entrance is sometimes claimed to be effective, but under what circumstances it is beneficial is unknown.

A number of insects, birds, and mammals must be classed as enemies of bees, but of these the two wax moths, and ants, are the only ones of importance. There are two species of moth, the larger wax moth (*Galleria mellonella* L.) and the lesser wax moth (*Achroia grisella* Fab), the larvæ of which destroy combs by burrowing through them* Reports are frequently received in the Department that the larvæ of these moths (usually the larger species) are destroying colonies of bees. It may be stated positively that moths do not destroy strong healthy colonies in good hives, and if it is supposed that they are causing damage the bee keeper should carefully study his colonies to see what other trouble has weakened them enough for the moths to enter Queenlessness, lack of stores, or some such trouble may be the condition favorable to the entrance of the pest, but a careful examination should be made of the brood to see whether there is any evidence of disease. This is the most frequent cause of the cases of moth depredation reported to this Department. Black bees are less capable of driving moth larvæ out, but, even with these bees, strong colonies rarely allow them to remain. The observance of the golden rule of bee keeping "Keep all colonies strong," will solve the moth question unless disease appears

Moth larvæ often destroy combs stored outside the hive. To prevent this the combs may be fumigated with sulphur fumes or bisulphid of carbon in tiers of hives or in tight rooms. If bisulphid of carbon is used, great care should be taken not to bring it near a flame, as it is highly inflammable. Combs should be stored in a dry, well ventilated, light room

In the warmer parts of the country ants are often a serious pest. They may enter the hive for protection against changes of temperature, or to prey on the honey stores or the brood The usual method of keeping them out is to put the hive on a stand the legs of which rest in vessels containing water or creosote Another method is to wrap a tape soaked in corrosive sublimate around the bottom board

GENERAL INFORMATION

For the purpose of answering numerous questions which are asked of this Department the following brief topics are included.

BREEDERS OF QUEENS

There are a large number of bee keepers who make a business of rearing queens of good stock for sale. The queens are usually sent by mail. If poor stock is all that can be obtained locally, it is recommended that such colonies be purchased and the queens removed and replaced with those obtained from a good breeder This Department can supply names of breeders nearest the applicant, of any race raised in this country

INTRODUCING QUEENS

When queens are shipped by mail they usually come in cages which can be used for introducing If the colony to receive the new queen has one, she must be removed and the cage inserted between the frames The small hole leading into the candy compartment is uncovered and the bees gradually eat through and release the queen If queens are reared at home a similar cage may be used for introducing

In view of the fact that disease may be transmitted in mailing cages it is always a wise precaution to remove the new queen and destroy the accompanying workers and the cage and its contents The queen may then be put into a clean cage without worker bees with candy known to be free from contamination (made from honey from healthy hives) and introduced in the regular way Queens sold by breeders are always mated unless otherwise specified and consequently the colony in which they are introduced has no effect on the offspring During the active season the bees in the colony are all the offspring of the new queen in about nine weeks Three weeks is required for the previous brood to emerge (if the colony has not been queenless) and in six weeks after all the old brood emerges most of the workers from it will have died

DEALERS IN BEE KEEPERS SUPPLIES.

There are several manufacturers of supplies in this country who can furnish almost anything desired by the bee keeper Some of them have agents in various parts of the country from whom supplies may be purchased thus saving considerable in freight.

BEE KEEPERS' ASSOCIATIONS.

There are a large number of associations of bee keepers in all parts of the country, formed for the betterment of the industry and a few associations which are organized to aid the members in purchasing supplies and in selling the crops. Of these the National Beekeepers Association is the largest. It helps its members in obtaining their legal rights, and aids in securing legislation for the furtherance of the industry The annual conventions are held in different parts of the country, and copies of the proceedings are sent to the members. There are also numerous state, county and town associations, some of which publish proceedings The names of officers of the nearest associations or of the National Beekeepers' Association will be sent on request from this Department.

LAW AFFECTING BEE KEEPING

Disease inspection.—Various States have passed laws providing for the state or county inspection of apiaries for bee-disease control, and every bee keeper should get in touch with an inspector when disease is suspected, if one is provided. The inspectors are practical bee keepers who fully understand how to control the diseases, and are of great help in giving directions in this matter The name of the inspector of any locality can usually be furnished, and this department is glad to aid bee keepers in reaching the proper officers.

Laws against spraying fruit trees while in bloom.—The spraying of fruit trees while in bloom is not now advised by economic entomologists, and to prevent the practice

*Circular 79, Bureau of Entomology, U. S. Department of Agriculture. The Brood Diseases of Bees.

*Bee keepers refer to these insects as moths, wax moths," "bee moths," "millers," "wax worms," "honey moths," "moth worms," "moth millers" and "grubs." The last two names are not correct.

some cities have passed laws making it a misdemeanor. Such spraying not only kills off honeybees, causing a loss to the bee keeper, but interferes with the proper pollination of the blossoms and is thus a detriment to the fruit grower. Bee keepers should do everything in their power to prevent the practice.

Laws against the adulteration of honey.—The National Food and Drugs Act of 1906, and various state pure food laws, are a great aid to the bee keeper in preventing the sale of adulterated extracted honey as pure honey. Bee keepers can often aid in this work by reporting to the proper officials infringements of these laws which come to their notice.

When bees are a nuisance.—Some cities have passed ordinances prohibiting the keeping of bees in certain areas, but so far none have been able to enforce them. If bees are a nuisance in individual cases, the owner may be compelled to remove them. The National Beekeepers' Association will help any of its members in such cases, if they are in the right, as well as in cases where bees sting horses. Bee keepers should be careful not to locate bees where they can cause any trouble of this kind.

SUPPOSED INJURY OF CROPS BY BEES.

Bee keepers are often compelled to combat the idea that bees cause damage to fruit or other crops by sucking the nectar from the flower. This is not only untrue, but in many cases the bees are a great benefit in pollinating the flowers, making a good crop possible. A more frequent complaint is that bees puncture fruit and suck the juices. Bees never puncture sound fruit, but if the skin is broken by some other means bees will often suck the fruit dry. In doing it, however, they are sucking fruit which is already damaged. These and similar charges against the honeybee are prompted by a lack of information concerning their activities. Bees may of course become a nuisance to others through their stinging propensities, but bee keepers should not be criticised for things which bees do not do.

Some Mental Illusions of Vision

Explanations of Various Optical Phenomena

By R. T. Lewis, F.R.M.S.

NOTWITHSTANDING the popular saying that "seeing is believing," neither of our faculties is subject to such complete illusions as our sense of sight, some being optical, others ocular, while again others are purely mental.

To the first kind belong those due to refraction—such for instance as the mirage or the apparent displacement of an object from its true position; to the second kind may be referred the phenomena of irradiation and of subjective images and colors; while the third includes the impression which most persons have of the apparent increase of the size of the Sun and Moon when rising or setting and the similar increase in the apparent size of constellations or the distance apart of stars when seen near the horizon as compared with our estimate of such at their meridian altitude.

That this last named illusion is neither optical nor ocular is shown at once by the fact that when seen through a telescope no such apparent increase is found to exist; indeed, when accurately measured after making all necessary corrections for height of barometer, temperature, and refraction in altitude, it is found that the apparent diameter of either body is really greatest when on the meridian, inasmuch as they are then some 4,000 miles nearer to us than when near the horizon, though the difference is too small to be appreciated by the naked eye.

It should be noted, however, that the amount of the apparent augmentation varies considerably with individuals; artists for instance depict the rising moon of a variety of exaggerated sizes up to about 15 deg. diameter, or about thirty times greater than it should be drawn, and one not infrequently hears it described as looking as large as a dinner plate, whereas a three penny bit held at arm's length is rather larger than is necessary to hide it completely.

That this almost universal illusion is entirely mental is not easy to demonstrate, although it will be readily admitted that if a false impression of the distance of an object can be created the mental estimate of its actual size will be proportionately altered. In other words, if an object we believe to be near to us appears of a certain size, and one of the same kind believed to be at a distance appears also of the same size, we at once from experience correctly judge that the latter must be the larger of the two. Hence though the Moon, whether high or low in the sky, practically subtends the same angle and therefore its image on the retina of the eye is in both positions the same, we naturally from experience imagine it must be a larger body in the latter case, because though so much farther off it appears to be of the same size as the Moon we see when apparently nearer.

The experiment referred to in the accompanying diagram affords a convincing illustration of the curious mental effect produced by the creation of a false impression of distance, and is one which may be performed by any persons who possess sufficient control of the eyes to dissociate the focusing and the convergence, which though quite separate and independent actions are from constant habit usually performed automatically together. *A B* represents a stereoscopic slide which we will suppose to be of the full Moon placed at the normal distance of ten inches from the eyes, when the two pictures are seen clearly in focus. If while retaining the focal distance we alter the convergence so that the axis of the right eye (*R*) passes centrally through the picture *B* and that of the left eye (*L*) through the center of *A*, as shown by the two firm lines *L C* and *R C*, these axes will meet at the point *C*, which will be more or less distant from the plane of *A B* according to the width apart of the eyes of the observer. The result of this will be that three images of the pictures *A* and *B* will be seen, of which the central one, consisting of *A* and *B* superposed, will be seen apparently at *C* and of course perfectly stereoscopic. If then without altering the distance between the eyes and the slide we look so cross eyed that the axis of *R* passes centrally through *A* and that of *L* through *B*, as indicated by the two dotted lines, we shall again see three images, the center one apparently at *D*, but in this case pseudoscopic. It is clear that in both cases the images of the pictures on the sympathetic portions of the retina will be approximately the same, but in the former case, where the Moon is seen apparently at *C*, or much farther off than it really is, the effect is that of a considerably magnified image, whereas in the latter case, where the picture is seen apparently at *D*, or much nearer than it really is, the mental impression produced (after making due allowance for the difference between *R A* and *R B*) is that of a considerably smaller Moon than either of those seen at *A B*, the mental illusion in each case being due to the fact that a false idea has been created as to the distances of the objects observed.

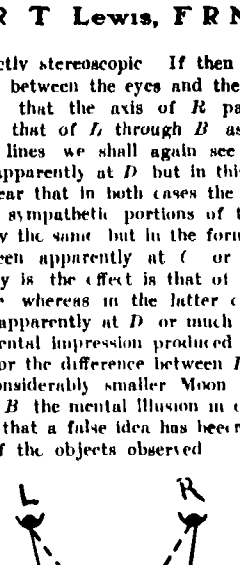

Diagram Illustrating False Impressions of Distance.

A further experiment may be suggested by means of the subjective image of any object which is gazed upon long enough to produce a continued impression upon the eyes. If for instance the filament of an incandescent electric lamp is steadily looked at for a few seconds, the impression produced by it upon the sympathetic portions of the eyes will persist until the vibrations so excited have run down, and a spectral image of the filament will meanwhile be seen so long as the convergence of the eyes is maintained at the same angle as when the lamp was originally looked at. If this image is projected upon the distant wall of the room it will appear of magnified proportions, whereas if thrown upon some surface nearer to the eye than the exciting cause it will apparently be seen of very reduced dimensions, although in both cases the actual picture formed must be precisely the same.

As yet another, though somewhat different class of mental illusion in the case of vision, I may mention that I have before me a photograph of the "Challenger" medal taken under a strong oblique light falling upon it from the top. Knowing from experience that if the light falls in that direction upon a raised surface the shadows would fall as depicted, the mental impression produced when the top of the photograph is held toward a source of light is that of a design in strong relief, although the sense of touch assures me it is flat; but if the picture is turned round so that the light falls upon it from the bottom experience immediately suggests that shadows, as they then appear, can only be thrown by an intaglio, and the mental suggestion is that of a sunk pattern, an illusion which would be complete but for the fact that the inscription still reads the right way about.

A false estimate of distance, and therefore of size, is very common to persons in the clear air of high mountainous regions who under ordinary circumstances are accustomed to see landscapes through our own more murky atmosphere, and the common illusion of meeting suddenly with gigantic figures in the street on a foggy night because they are much closer than imagined will occur to most people.

It seems also quite within the limits of possibility that some of the errors of interpretation as to the meaning of what is seen under the microscope may be due to mental suggestion.

It will be understood that the extent of such illusions as have been referred to varies somewhat according to the personal equation of the observer, and that what has been described is simply the experience of the writer, who it may be of some interest to mention has since he thought out the matter almost entirely lost the impression that the Sun and the Moon appear larger when rising or setting than at other times, though he has been quite unable to divest himself from the illusion in the case of constellations or stars.—*Knowledge.*

Moving Picture Camera as a Hand Camera by Using a Gyroscope

AT a recent meeting of the Société de Physique of Paris, an interesting method of taking moving picture views was presented by M. De Proszynski. Heretofore such a camera had to be mounted on a tripod to keep it quite steady and it was generally turned by a hand crank. The inventor succeeds in making a hand camera for use in taking such views. He keeps it steady by using the principle of the gyroscope in an ingenious way, so that holding it in the hand causes no trembling. But the problem was how to drive the gyroscope and also the film machine, as an electric motor with a battery is not practical, neither is a spring motor. He uses a small compressed air motor devised for the purpose, and it is very compact. It gives no shocks when running, which is, of course, an essential point. A unique feature is that an ordinary bicycle pump is used to fill the air cylinder of the motor, so that the whole can be made in the form of a hand camera about the size of a large kodak, and it is thus self contained. The inventor showed what the camera would do by projecting some street views on a screen. These were taken when moving the camera about in the hand quite rapidly, and the images were remarkably sharp. We expect to illustrate this apparatus in the near future.

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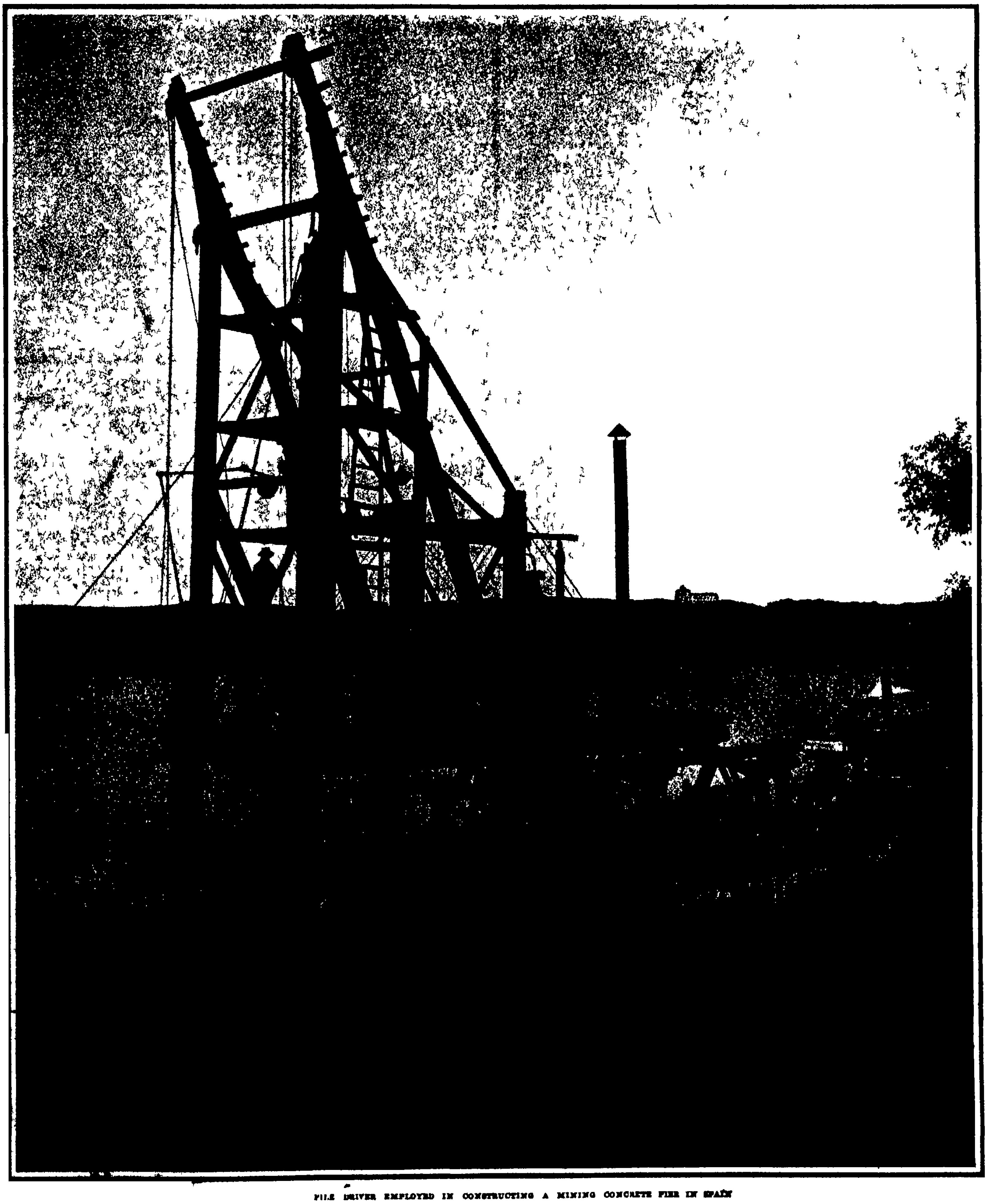


PILE DRIVER EMPLOYED IN CONSTRUCTING A MINING CONCRETE PIER IN SPAIN

A SPANISH MINING CONCRETE PIER.—[See page 159]

The Chemistry of Cellulose*

A Substance Little Understood

By Carl G. Schwalbe

The first attempts to substitute other prime materials for rags, old linen or cotton waste, for the manufacture of paper date from the middle of the eighteenth century. Even at this time these prime materials were getting scarce. Christian Schaeffer of Ratisbon attempted in 1765 to make paper from wasp nests, turf, straw, hay, the twigs of hops, from brush broom, and even from wood, but his efforts brought no results except the contempt and jeers of his contemporaries; the time had not yet come to realize this idea, and moreover the scarcity of rags had not yet become pressing. But when the development of daily newspapers and the necessity of satisfying the demand arising from the extension of popular instruction had made these ideas acceptable, the search of substitutes for rags became permissible; thus it was that towards the middle of the nineteenth century the attempts of the weaver Keller to de-fibre wood so as to obtain a pulp to replace the pulp from rags were favorably considered. There should be remembered too the attempts made by Melliers, among others, who frequently tried to treat straw so as to extract from it a pulp which could be used industrially. Cellulose treated with soda soon followed the mechanical wood pulp and straw pulp. In fact the process of treating wood, as well as straw, with caustic alkalies or alkaline earths became a success. Moreover, very soon after this alkali process had been brought from America to Europe by Houghton, it found a competitor in the chalk process or in the sulphurous acid or bisulphite process. The names of Tilghman and of Ekman are connected with the first experiments made in Germany to use calcium sulphite or magnesium sulphite for this treatment. At this time this process, which had been kept secret, fell into oblivion. The energy and determination of Mitscherlich and his licensees developed a practical industrial process which, concurrently with the analogous process of Rittner-Kellner, soon brought the new industry to an extraordinary stage of development in the short space of twenty-five to thirty years.

The production of cellulose amounted to 1 600 000 tons of the value of $80 000 000; the production in Germany was estimated at 564 000 tons worth $28 000 000; the proportion of cellulose treated with caustic soda was very small. This was due to the fact that for various reasons still disputed the bisulphite process of treating wood seemed superior to the soda process. However, in spite of the considerable extension of this process, in spite of the great progress it has made as to the yield both in quantity and quality of the product, hence the certainty of the methods of manufacture, still the cellulose industry depends almost entirely on empiricism. The chemical composition of the raw material wood and of its manufactured product cellulose is still almost completely unknown to us.

The cellulose industry and its allied industries of cotton, gun cotton, and artificial silk are thus in an analogous condition to some other industries, for example the leather industry; from this point of view they are in a totally different condition from the great industry of inorganic chemical products or of coloring matters. In the case of these last industries, the exact chemical knowledge of their raw materials and of their intermediary products has allowed them to advance very methodically and in well chosen paths, and this has made their recognized brilliant development possible.

May I be permitted here to make a rapid sketch of what the cellulose industry and its allied industries are; to point out what problems are not yet solved, the solution of which is demanded as much by the chemist as by the technical man, and to express how necessary it is to base these industries upon more solid chemical knowledge than they actually possess at present?

To begin with, let us consider the manufacture of mechanical wood pulp; 500 000 tons, worth $12 500 000, are produced annually in Germany. At first sight this manufacture does not seem chemical. In fact, the decorticated wood is crushed flat between millstones and under a stream of water either perpendicularly to the course of the fiber or with the fiber; the fibrous pulp thus obtained is refined, freed from splinters of wood, and then worked in different ways so as to yield various products, such as straw board, but chiefly the substance to which a small quantity of cellulose is added to make the paper for the daily journals.

If one of the stages which this process has lately reached is studied, that known as the method of refibring by the hot process which came from America, we are plunged at once in a chemical problem. In this method as a preliminary treatment, recourse is had simultaneously to boiling water and a very high pressure, working at as low a temperature as possible.

Boiling with water under these conditions, when it is for a short time only, appears to dissolve a certain part of the wood and to yield a very large quantity of very long fibers, with a small residue of broken fibers. The effect naturally goes much further if the water is allowed to act for too long a time and under greater pressure. To obtain very resistant fibers, certain constituents of the wood are dissociated and then the custom is to recover them by the production of the brown mechanical pulp. This pulp is specially used to make a very strong leather board. Unfortunately, carbonisation begins during this process. According as the temperature and the pressure (four atmospheres on the average) are more or less high, a correspondingly more or less marked brown color is produced. Is this due to the formation of humus? As vanillin and acetic, formic, and oxalic acids are found in the residual lye, it is not improbable that oxidation is set up.

It has been attempted to remove this extremely troublesome brown color by bleaching, but in vain. However there appears to be some hope of success of preventing the production of this brown color, that is of preventing the oxidizing agents from acting, to effect this, either the air in the autoclave (digester) and in the pores of the wood is removed by producing a vacuum in the autoclave, or, before boiling, the wood is impregnated with a solution of a reducing agent, such as sodium sulphide. Besides this question of discoloration, other technical problems present themselves; in any case there is the utilization of the residual lye which may contain as much as ten per cent of the weight of the treated wood. The solution of this problem opens up many scientific questions: From what portion of the ligneous substance are the organic acids derived? Is the process an hydrolysis? Above all, what is wood? And if in the course of our researches we take up those which refer not only to the mechanical pulp of brownwood, but also those which concern the white mechanical pulp, how is it that the paper made from mechanical wood pulp turns brown so quickly? And how shall we determine the amount of wood in a mechanical pulp when it is mixed with other fibrous substances? Very recently Messrs. Cross and Bevan have answered this question by an approximate solution. A solution of phloroglucin in hydrochloric acid gives a beautiful purple color to wood, which has long been used for the colorimetric determination of the quantity in mechanical wood pulp. But the two English savants have found that, as well as this color reaction, there is a notable absence of phloroglucin by the wood pulp in fixed proportions by weight. If wood pulp or a substance containing wood pulp is placed in a solution of phloroglucin of known strength, and at the end of a certain time the strength at that time of the solution is determined, the quantity of phloroglucin consumed allows a conclusion to be drawn as to the amount of wood in the pulp.

The absorption of an inconsiderable quantity (six to seven per cent) of phloroglucin by lignin, led Cross and Bevan to recognize in this fact a proof that only the ketone compounds and not the aldehyde compounds act in this way, for the aldehyde compounds will have been oxidized by the chlorine and could not give this reaction. This assumption formulated by the English scientists, on the presence of compounds reacting in the lignin, leads us to recognize quickly the hypotheses which have been made on the subject of lignin. Scientists are agreed in admitting that there must be an aromatic nucleus in lignin. Czapek by heating sawdust (wood shavings) in water under pressure obtained a substance which he called *hadromal* which was recognized later, thanks to the work of Graefe, as being a mixture of vanillin, methyl furfurol and pyrocatechin. Graefe concluded that from the quantity of methoxy compounds in the wood the quantity of vanillin could be deduced, and further that this must be the chief constituent of lignin. It is not necessary, however, that all of the methylic compounds should produce the vanillic nucleus, as Fromherz has shown. Moreover it appears very probable, according to the recent researches of Klason, that lignin is composed of coniferyl alcohol (a compound closely related to vanillin) and of a derivative of this alcohol, oxyconiferyl alcohol, for four similar nuclei have been formed by separating the water. This constitution would be allied to that of the carbohydrates and should be of the same character as a glucoside. In fact when water acts upon wood a solution is obtained containing ten to twelve per cent of a wood gum, which is a carbohydrate, from which proportion the content of lignin is deduced as twenty-six to thirty per cent. It is remarkable that invariably only 1.4 per cent of carbohydrate is found in the residual lyes of the bisulphite process; it must be admitted, then, that the pressure, the rise in temperature, and the chemical agents have a destructive action. Let us remark, in passing, that it is possible after that to answer the question so many times asked, whether it is not possible to manufacture vanillin by utilizing either the residual lyes derived from the hot process of making wood pulp or the lyes from the bisulphite process. At the very low price of $4.55 per pound, which is the present price of vanillin, no one would be interested sufficiently to make the extraction. Besides, it must first be considered that the demand for vanillin is not so important now, and that if this question was solved, it would not solve the problem of utilizing not only the cellulose, but also the lignin of wood.

These considerations have led us face to face with that problem of the cellulose industry which is the most difficult to solve and at the same time the most important. What will become in the future of those innumerable organic substances dissolved in water, when our rivers refuse to accept them; or what will remain, even of the business itself, when the laws protecting water courses, threatening even now, become active, and forbid us to throw the residual lyes into them in such large quantities as has been done up to the present time? The quantity of organic matter dissolved in water is nearly equal to the 564,000 tons of cellulose, and a means must be found of destroying it.

Having given the outline of this discussion, it is impossible to detail the numerous processes which have been suggested for the utilisation of the residual lyes. However, that attention may be called to the most recent of the processes in this direction, it will suffice to mention the one now on trial at Langen in Hesse. By heating the residual lye from the chemical wood pulp of the bisulphite process in the presence of acids and, when required, applying pressure and adding formaldehyde, a tough and plastic body precipitates. The question now is to ascertain if this product really has such desirable properties as will allow of its use in such a way as to assure a large demand for it. This product may be considered as cellulose pitch. This is the name given to the product obtained at Walsumam Niederrhein by evaporating the residual lyes nearly to dryness, and has proved to be an excellent agglutinant for the agglomeration of powdered minerals. The whole question lies in knowing if, in such a case, the cost of evaporation would not be too great, in which event the process is of no value from an economic point of view.

In the production of cellulose by soda, the residual lyes need not cause any uneasiness. These lyes are concentrated and then calcined to extract the alkali contained in them.

In this case the organic matter which the lyes contain partly furnishes the fuel necessary for their recovery. On the other hand, to compensate for the absence of the problem of how to get rid of these residual lyes, this process has one great drawback which explains why it is not more frequently adopted; the treatment of these residual lyes sets free very noxious fumes which, up to the present, cannot be avoided. This inconvenience and the small yield of cellulose are the reasons for the abandonment of this process in Germany. At this moment, laws are being prepared in Scandinavia, with a view to the total suppression of the noxious fumes from this manufacture, and thus the existence of the industry of making cellulose by the soda process is strongly menaced in those countries.

But the utilization or the suppression of the residual lyes are not the only important problems. Cellulose, whether obtained by boiling with alkalies or from an acid solution, must be bleached. This does not mean merely to destroy the very slight color of the chemical pulp of heated wood, but rather to carry out an operation, which is a true chemical attack accompanied by a great loss of weight (four to ten per cent in the case of bisulphite cellulose). There is no doubt that the discoloration would be much more intense and much more difficult to destroy in the case of caustic soda cellulose than it is with bisulphite cellulose. We do not know the nature of the color; besides this problem has remained unsolved in another industry, the elder sister of the cellulose industry, the manufacture of cotton, for the coloring matter which causes the discoloration of raw cotton is not clearly recognised; it is only known that it seems to act as a caustic, a destroyer. As it seems to us, instead of completing the treatment by bleaching it should be asked if the bleaching cannot be done during the treatment? Experience has taught that if the treatment is pushed too far the quantity and quality of the product are influenced to a considerable degree. The treatment should be considered as a sort of hydrolysis, so that on continuing it too long not only the lignin, but also the cellulose itself is attacked. Thus in the soda process, it must be admitted that after the solution of the compound (analogous to an ether) which is formed by the cellulose and the lignin, the lignin is changed into lignic acid by the alkali, for Lange obtained not only cellulose, but also a certain quantity of lignic acid, by fusing wood and alkali together. The theories that have been suggested as to the reactions in the bisulphite process are very diverse; whether the acid radical or the sulphurous acid remains in the state of a double salt, or whether it reacts with the aldehyde compounds, or again whether it forms ethers or sulphonated acids. The last view is one of the most accepted, thanks to the work of the Tollens laboratory; in fact, the presence of a sulphonated acid combined with the lignin, has been recognised in the residual lyes of the bisulphite process; and from this compound, though with great difficulty, by means of alkalies, a sulphonated acid has been separated at the same time as a lignic acid, apparently identical with that obtained from the soda process.

It seems to us that these considerations only concern lignin. But what can we say relatively about cellulose? Is there really a unique cellulose which is isolated when the boiling is not continued too long? Are there fixed quantities of a less stable cellulose which go into solution? It is certain that this is the case in the soda process of making cellulose; in fact the yield is fifteen to twenty-five per cent less than that obtained in the bisulphite process, and the product even after bleaching does not always appear identical with cellulose from cotton; for among other distinctions it reacts with phenylhydrazine, and forms furfurol when distilled with hydrochloric acid. Are these reactions due to the existence of a mixture of several different celluloses, or are they due to a *single* cellulose, or again are they due merely to impurities, difficult to remove? What will remain when these impurities are eliminated? It is plain, then, there is no lack of unsolved questions and that all of these [illegible]

*Translated from the *Moniteur Scientifique*

or less, await their solution by work based on experiment. But that is not all. The different kinds of cellulose formed during the boiling show still more subtle differences and present an immense field for purely chemical research, for, up to the present time, the various kinds cannot be completely differentiated by their physical properties There are certainly different kinds of cellulose pulp obtained, according as they are treated by slow boiling as in the Mitscherlich process, or by rapid boiling as in the Rittner-Kellner process.

Are all these different hydrates one and the same cellulose like that of cotton? These questions remain for the most part unanswered Only one of the questions relating to the carbohydrates has as yet received a reply It is now known, at least, that by excessive treatment of the bisulphite cellulose, a transparent substance is obtained, looking like parchment externally and quite comparable to vegetable parchment, which has been called *pergamyn*. But pergamyn is not a cellulose hydrate, but rather a cellulose boiled to the condition of boiled (sodden) rags, and from a chemical viewpoint is clearly distinguished from the hydrate, which is vegetable parchment by the reagents iodine and potassium iodide; the parchment alone, a cellulose hydrate, becomes blue

Up to now we have only spoken of wood and of the cellulose extracted from it Without going farther, other problems present themselves when the different ligneous essences are considered as subjects for research How to recognize the different kinds of wood and the celluloses they yield, the evergreen woods such as pine and fir and the wood with decaying foliage of which those chiefly used are the poplar, the birch, and the beech Every kind of cellulose produced from these different woods should be clearly distinguished

Besides wood is not the only raw material which produces cellulose Cellulose can be extracted from other ligneous fibers particularly herbaceous plants In Germany it is made from wheat and rye straw in England and in the rest of continental Europe from esparto grass or alfalfa This last can be disintegrated by a fermentation analogous to the steeping of flax, but the soda process is principally used This process only is applied to straw When the sulphate process is used i e, the process when the work of sodium hydrate is completed by sodium sulphate a forty two per cent yield of a cellulose is obtained which from its reactions should be considered as an oxycellulose although it is not as yet very thoroughly understood In spite of its comparatively weak mechanical resistance as compared to bisulphite cellulose, it furnishes a raw material very applicable for manufacturing letter paper The problem of the residual lyes is the same as in the case of boiling wood with soda Really, in the recovery of the alkali the most interesting question is that of the noxious fumes but the lyes also doubtlessly contain substances of considerable alimentary value, and further, substances which are gelatinous and have a certain coloring power, of such a kind as to offer one more reason for attempting to utilize these lyes in an advantageous manner

The considerable development of the manufacture of cellulose, both from wood and straw gives rise to the fear of a dearth of raw materials in the future Thus the German cellulose factories are already treating wood brought from the shores of the White Sea If the devastation of the forests should progress rapidly in the northern countries, the cellulose industry will be stopped by the want of raw materials There is so much the more reason that our country should be able to furnish the quantity of wood demanded by the industry Besides the available quantity of straw is very limited The indigenous plants which should furnish large quantities of fiber suitable for paper making are not at our disposal for the hope of converting turf into a fiber utilizable for paper has proved deceptive Since considerable capital has been swallowed up in attempts to effect this, it would appear prudent to give it up completely In any case there still remain reeds but only for our Austro-Hungarian neighbors In fact it seems that in the delta of the Danube and in the lower Danube region reeds are found from which there can be successfully extracted a cellulose analogous to that from straw In any case it must not be forgotten that the quantity of available fiber here is not very large Hence for the future of paper making in Germany, we must look to our colonies

For the moment let us imagine that plants could be treated where they grow, in some way so as to decrease as much as possible the dead weight for transportation, and could be sent to Europe in a half prepared condition According to information from an English origin, in Burmah alone there are 60 000 square miles covered with bamboo jungles close to navigable rivers Granting the rapid growth of these plants, it has been calculated that an area of 16 square miles would be enough to furnish the raw material necessary to make 100 tons of paper per week. It follows that Burmah, that small part of India, would alone suffice to furnish as much cellulose as the whole world demands. The scarcity of wood, however, is not yet so pressing that there is any need to introduce the cellulose manufacture in countries with a murderous climate, to consume enormous capital, and to expose it to the difficulties of considerable hand labor From this point of view America is much better off Putting aside the fact that in this country it is still possible to devastate the forests on a large scale, instead of having recourse to the creation of a new industry, the short fibers which adhere to the cotton bolls can be used, and the residues and waste of raw cotton, about 600,000 tons of raw material further there is still available about 22 000 000 tons of cotton stalks which have been hitherto considered of no value and are buried by the plow every year At the same time, and in an analogous manner, the maize stems wild hemp, marsh herbs, and wild rice are wasted Some of these American sources already feed the German paper industry Thus the factories at Bremen treat cotton utilizing the fibers sticking to the cotton bolls and using them to prepare a product commercially sold under the name of Virgo fiber (thread)

Another very important industry and to an extent closely allied to the cellulose industry has also developed greatly, that of artificial silk That, too, uses cellulose as the raw material The total natural silk in the world is estimated at 50,000,000 kilograms (110,230 000 pounds) worth $350,000,000 the production of artificial silk has reached 5,000,000 kilograms (11,023 000 pounds) worth $20,000 000 Although the use of natural silk has not yet diminished in favor of artificial silk the foregoing figures show the growing importance of this new and quite young industry; quite young for it only began in 1880

In the beginning cotton cellulose was the only thing they dreamed of using The cellulose was treated with nitric ether (*sic* nitric *acid?*), the product thus obtained was dissolved in a mixture of alcohol and ether and the solution transformed into thread which, by the use of reducing agents, such as calcium sulphide was rendered uninflammable Soon however a second process came into use, which consisted in dissolving cotton cellulose in a cupro-ammoniacal solution spinning this solution and coagulating it by means of acids or bases A third process the production of viscose silk, has lately been added to the preceding ones

But the development of this industry has not answered to its early promise on account of the high price of its raw materials, viz wood cellulose carbon bisulphide and soda lye; in fact, the manufacture is much too difficult It is only after twelve years of efforts that the scientists Cross and Bevan succeeded in making the process practical, and thoroughly mastered what they termed the "maturing" of the viscose Really when the three processes were yet in the midst of their development they encountered a fourth and most serious competitor which came on the scen although it is true that no marketable product of this process seems yet to have appeared in commerce, that is silk from cellulose acetate

While the three kinds of artificial silk mentioned earlier contained only cellulose regenerated in different ways, in this case the finished thread contained an acetic ether of cellulose This ether is insoluble in water and moreover preserves its mechanical (physical) resistance in presence of water a quality to which the other artificial silks cannot pretend except in a very limited degree The artificial silks from nitrocellulose from ammoniacal copper and viscose silk are in themselves less substantial than natural silk but when they are damp they lose a great deal of the little resistance they possess This drawback of preponderant influence has already made itself felt in dyeing but it makes itself felt still more during the weaving when the fibers come in contact with water or with damp air Silk from the acetate does not suffer from exposure to humidity At first great difficulty was experienced in dyeing because aqueous solutions of coloring matters would not penetrate the fiber but by using agents which swelled the fiber these difficulties were overcome There is no need to enlarge on this subject because a short time ago Prof Knaevenagel enlightened us as to the tinctorial properties of acetyl cellulose in a very interesting lecture with experiments that he gave at Heidelberg at the reunion of the Association of South German Chemists

All that has been previously said as to the chemical difficulties applies also to the conditions in which the acetate is produced The use of acetic anhydride and a little sulphuric acid at the same time results in the very great instability of the ethereal solutions thus obtained and this causes more or less fragility of the threads or films which have been produced Now these difficulties are avoided by various methods In Knoll & Co s patents we find sulphuric acid replaced by benzolsulphonic acid as suggested by Knaevenagel, as well as the addition of neutral salts to the alkaline salts used as regenerators The effects of these modifications are: To stop hydrolysis which is not desirable to prevent the destruction of celluloses of large molecular weight, and to obviate any ulterior modification of the physical properties of the product obtained Aside from the solution of this problem, an appropriate solvent has also been sought for several years Now acetone and acetic ether have become the regular solvents, while formerly no one dreamed of using anything but chloroform glacial acetic acid or analogous liquids, which made the practical use of cellulose acetate very difficult Thanks to the kindness of Prof Knaevenagel and the firm Messrs Kroll & Co, I am enabled to show you here some samples of cellulose acetate and of artificial horse hair the production of which is still in the experimental stage At the same time, I can show you, thanks to the kindness of the color manufacturers, Messrs Frederic Bayer & Co a fine collection of sensitive preparations with a cellite (cellulose acetate) base As you have already learned at our general meeting at Jena something of cellite films it appears that the problem of the inflammability of kinematograph films (hitherto made of celluloid) has been entirely solved

The destruction of the cellulose molecule pushed too far during the etherification referred to above is the cause of great difficulties not only in the production of acetate, but also in that of Chardonnet s Glanstroff silks, and of viscose silk which should be included in fact, during the regeneration of cellulose not only cellulose, but also a cellulose hydrate is produced This hydration must be considered as the reason for the weak mechanical resistance of the thread in the presence of water According to Eschalier this inconvenience can be avoided by treating viscose with formaldehyde in acid solution Eschalier is convinced that formaldehyde induces the spontaneous reconstruction of the molecule previously destroyed According to his figures, the mechanical resistance of viscose silk thus treated is increased in a considerable degree There still remains the question whether in spite of the increase in solidity the elongation (extension) is still sufficient for it is the low value of these two properties which has hitherto so unfavorably distinguished artificial silks from natural silks The most important problem in the industry of artificial silks that still remains to be solved is that of endowing them with these two properties

There is still to be mentioned the complication of questions relating to cellulose hydrates found in Knecht s recent work on mercerized cotton He shows that the absorbent powder of cotton differs remarkably according to whether during mercerization it has not been dried at all or has been dried and if dried whether this has been done at the ordinary temperature or at 100 deg C (212 deg F) Hence different methods of drying give rise to different hydrates Also Berl states that if cotton is heated in a current of inert gas at a high temperature, it undergoes polymerization which exerts a favorable influence on the properties of the resulting nitro celluloses

These considerations make it sufficiently clear that in the cellulose industry and its allied industries in spite of the numerous isolated observations the characteristics of cellulose or the celluloses are very imperfectly known from the chemical point of view We do not even know the constitution of the cellulose of cotton which may be taken as the type and still less of its derivatives— the cellulose hydrates the hydrocelluloses and the oxycelluloses We can only form a vague idea of these bodies If the cellulose industry is to continue to progress, it is absolutely necessary that a systematic study be made of all the bodies included in the above category

An advance in the study of their constitution can generally be effected either by the synthesis or the analysis (destruction) of these bodies There can be no question at present of constructing a molecule of cellulose, but by destroying an apparent molecule, a certain enlightenment seems to have been obtained By making decomposition products we have only a very superficial idea of the celluloses hydrates but we already know a little more about the hydrocellulose we specially know thanks to Tollens that when the oxycelluloses are heated with milk of lime (calcium hydrate) they yield dioxybutyric acid and isosaccharic acid, we know that they form sugar by hydrolysis in an acid solution and by the same method a body representing an intermediary state of transformation between sugar and cellulose—cellobiose

The theory based on the figures representing these decompositions would be very fruitful and would be still more so if the researches were made under similar conditions on the large number of celluloses that can be isolated from wood and herbaceous plants It is highly probable however that resort must be had to new methods of research The future will tell us if these new methods should to some extent encroach on the boundaries of the chemistry of the colloids In spite of the successful results found in the domain of the chemistry of the inorganic colloids it seems as if the organic colloids, cellulose among them would escape from disclosing the secrets of their constitution like so many colloidal substances Whether it be by purely chemical methods, or by physiochemical methods there is no doubt in any case that those who devote themselves, regardless of the labor, to such serious experimental researches will have greatly accelerated the progress of the chemistry of cellulose as well as that of pure science and that the progress of the cellulose industry will likewise be facilitated

Additional Points about the New Paris Subway

We are able to give some additional points about the new Paris subway which has been lately opened. At one of the terminal stations there has been installed a very complete system of switch and signal control This is necessary from the fact that the subway does not make a loop and the trains need to be shifted to the return tracks Besides, there are other tracks laid which lead to the station yards near by, so that here there are used in all seven tracks Switches and signals are worked by Taylor electric motor devices, and their circuits come to a central operating switchboard. On the board is a reduced plan of the whole plant, with pilot lamps and indicators, so that the electric operating switches can be worked to suit the case There are 19 interlocking levers used in all. The motor cars carry Vedorelli double pantagraph trolleys with rubbers of special alloy, one on each end of the roof, and these work under the trolley wire which is mounted on brackets with 60 feet average span The third rail weighs 60 pounds per yard, and is supported on stoneware insulating blocks which are found to be moisture proof For connecting, the front car motors are joined to the trolley and the grounded track rail, and the rear car motors from third rail to track rail, on the three-wire system, using 600 volts on the motors or 1200 volts in all The substations contain four special rotary converter groups of 1,500 kilowatt size fed by alternating current from a bank of 1600 kilowatt three phase transformers The groups supply direct current at 1,200 volts for the subway circuits A storage battery furnishes an extra lighting circuit which runs through the subway as a standby Metallic filament lamps are used in the subway, and carbon lamps in the trains Improvements are made in the block signals so that the trains are never stopped in the tunnel, but can always run into a station provided this is clear and passengers can thus leave the train in case of accident that may arise from various causes.

Modern German Police Call and Fire Alarm Systems

Some Recent German Designs

By Frank C Perkins

Every modern fire department and police department must have a trustworthy call and alarm system An effective and reliable call and alarm system is as necessary as an efficient police equipment or effective apparatus at the fire itself The accompanying illustrations show the construction and method of operation of modern fire alarm systems of German design and construction and police station equipment in the city of Rio de Janeiro Of the accompanying illustrations Fig 1 shows the switch board and receiving apparatus at this installation while Fig 2 shows the relay table and illustration Fig 3 the master clock utilized in connection with the recording mechanism of the calls sent in from the various boxes The diagram Fig 4 indicates the circuits connecting the alarm boxes with the various station houses as well as with the central station There are from 5 to 15 alarm boxes in each circuit connecting with the receiving apparatus at the station

At Rio de Janeiro there are a total of 580 call boxes connected in circuits as indicated special boxes mounted on posts being provided with telephone equipments for communicating with the various stations and with head quarters The turning of the key in the door of the box sends in the call automatically to the station, the number being recorded on a section of the tape as indicated in drawing Fig 5 together with the date, giving the year month and day as well as the hour minute and second when the call was sent in

The switchboard equipment alarm boxes and electrical connections as utilized at Essen and Ruhr and other cities and towns in Germany are shown in illustrations Figs 6 10 The station equipment at Essen is shown in Fig 6 the design of the alarm box in the city being noted in Fig 7 The fire station equipment of smaller towns may be seen in illustration Fig 8, including the receiving apparatus the alarm gong in the station and telephone equipment as well as the alternating-current bell ringing magneto for calling the firemen from their homes in various sections of the town Fig 9 shows the construction of an alarm box for a small city while Fig 10 shows a more elaborate equipment for larger cities

Everyone is familiar with the electric house bell The current traverses the circuit only for a moment in which it does its work Such a system is called an 'open circuit system With house bell installations, failures of the current or defects are not evident until one attempts to use them An open current installation therefore is useful only for fire alarm systems under limited conditions

When this arrangement is reversed the current is allowed to flow steadily through the circuit and as soon as a signal is given the metallic circuit is interrupted In such a system any interruption of the current due to a break in the current will without any aid sound the alarm signal Thus we obtain the desired automatic control in a very simple way As in this method the current is always flowing during the normal condition of the installation it is called a "closed circuit system" This method of operation is used in all modern fire alarm installations

A closed circuit for interrupting the current with push buttons is the simplest kind of a fire alarm system In such push button installations one could of course without further equipment make the alarm-sending point distinguishable at the central by having the button simply releases a spring clockwork placed within the alarm box The clockwork then rotates a metal disk having a toothed edge The disk is brushed by a spring-metal strip, which when at rest, presses continually against the contact screw The current flows through the spring brush to the contact screw and as soon as the turning of the disk allows the brush to fall into a slot,

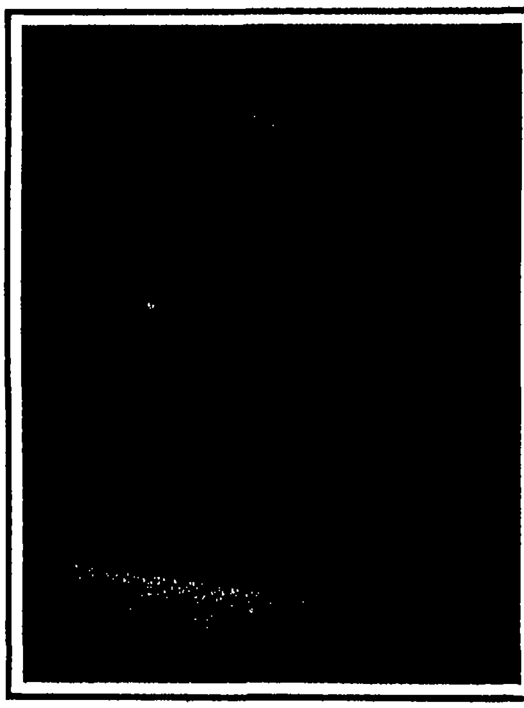


Fig 2—RELAY TABLE OF RIO JANEIRO INSTALLATION

the metallic contact between the brush and the contact screw is broken thereby sounding the signal at central When the brush has passed a slot the circuit is again completed and in accordance with a number of slots a particular number of current interruptions is produced Therefore the disk alarm box No 1 has one slot, that of say alarm No 8 has eight slots, it therefore allows that it must be simple to make the number of the particular alarm box recognizable at central In practice the disks in the different boxes not only differ as to the number of teeth but also as to their size and their spacing on the disk; in fact they are so arranged that the disk can send regular Morse signals to be recorded at the central station

Moreover it is possible to put as many alarm boxes as desired on a single line for as each alarm box has a different numbered disk no errors can occur Upon receiving an alarm at central it merely remains to look up the number on the register which shows the place from which the alarm was sent The circuit starting from the central station is run through all the alarm boxes in means of a special rubber washer The importance of this is very evident, as fire alarm boxes are usually in the open and constantly exposed to the weather The clockwork would suffer so much through dust, moisture and oxidation that reliable operation would soon become questionable, particularly as in small installations there is usually no skilled labor available to attend to the inspection of the boxes For the same reason the contact arrangement of the clockwork is constructed with particular care, in fact, for reasons of safety, the most important contracts are provided in duplicate The clockwork case is set in a red japanned outer cast iron case.

Large and elaborate alarm boxes are used for large cities as seen in illustration Fig 10, but are usually too costly for small installations Inside of the box, in addition to the clockwork with a case, is a lightning protector and contact key The key is employed by the firemen for special purposes in calling the central station In the front door is the push button, covered by a thin glass pane the only part of the signal sending mechanism accessible to the public Signal sending by pressing a button was intentionally chosen, as everyone is familiar with the push button which is widely used. The glass pane, about 1/64 inch in thickness, can be easily broken by a light blow

It has been found that covering the push-button by a glass pane has proven the best means of preventing the ringing of false alarms An uncovered handle or push-button would directly tempt mischievous or malicious misuse Moreover the use of the glass pane has the advantage that legal punishments for the wrongful misuse of an alarm box become more severe (the breaking of the glass being a damage to property) than it would be for the simple misdemeanor of sending a false alarm

In some German fire alarm systems in order to reduce the misuse as much as possible and make it easier to catch the malefactor, a loud ringing mechanical vibrating bell is often put in the door of the alarm box Pressing the button here releases both the alarm mechanism and that of the warning bell, which latter rings for a certain length of time and then stops of its own accord. It serves the purpose of calling the attention of nearby residents and of passers-by to the fact that some one is sending in a fire alarm This arrangement has proven very satisfactory It is not necessary to provide all the alarm boxes with bells Usually only those located in the residence section require them

As a receiving apparatus for small systems the direct indicating apparatus has proven itself very reliable. The indicating apparatus noted in Fig 8 contains, in back of a locked glass door a signal annunciator disk and a line relay transmits the incoming signals to the actual indicator or pointer system the dial of which shows the various alarm box numbers For practical reasons not more than 16 or 20 alarm boxes on one circuit are connected to one indicator If there are more alarm boxes or circuits a second indicator is required in addition to the first

When the glass of an alarm box is broken and its clockwork released the signal annunciator disk at the central station falls, the pointer moves—following the current interruption by the alarm box clockwork—and remains stationary at the number of the sending box. At the same time an alarm bell rings and continues ringing until someone has raised the annunciator disk and by

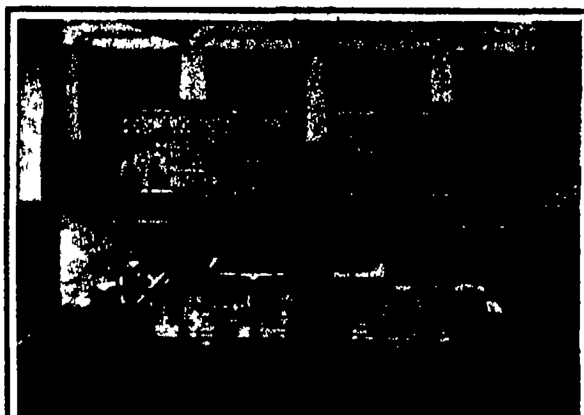


Fig 1 SWITCHBOARD AND RECEIVING APPARATUS AT THE INSTALLATION OF THE CITY OF RIO JANEIRO

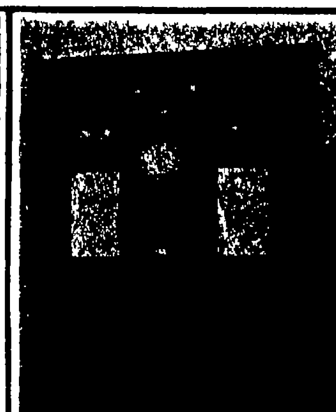


Fig 8—FIRE STATION EQUIPMENT OF A SMALL TOWN

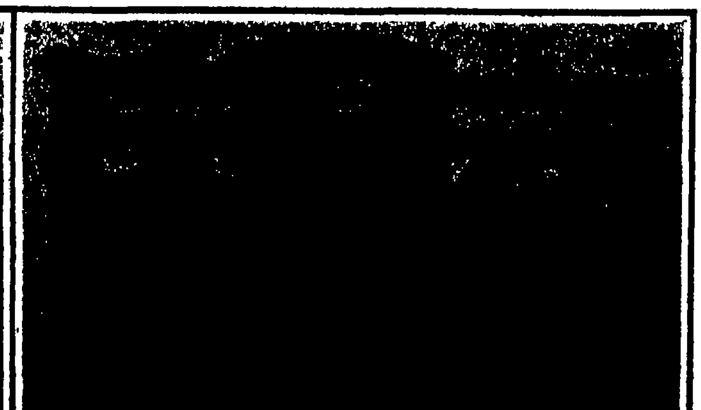


Fig 6—STATION EQUIPMENT OF THE TOWN OF ESSEN, GERMANY

pressed once at Station 1 twice at Station 2, and six times at Station 6 but in the excitement mistakes are unavoidable So it becomes evident that the interruptions of the current to denote the number of the sending point, instead of being controlled by hand, should be automatic.

A German device of this kind is operated as follows, and indicated in Fig 9: The alarm sender does not directly interrupt the current by pressing the button, but the city and then back to central. This is called a series circuit" or loop For practical reasons not more than 20 alarm boxes are put in one loop, a second loop entirely independent of the first being run as soon as more alarm boxes are added to the system.

It will be noted that the clockwork of the fire-alarm boxes of German design is mounted on a cast iron plate, placed in a small case and made absolutely waterproof by pressing a lever has brought the pointer back to its initial position.

In small cities the receiving station is situated at some suitable place as the City Hall, the police headquarters or the fire engine house where some one is always stationed at night, who, after receiving an alarm can reset the indicator apparatus and arouse the firemen. The alarm must be heard because of the continuously ringing

loud alarm bell. The person left in charge of the station over night can go to sleep, and be sure of being awakened by the alarm.

In larger cities where there is a regular fire department, or a small force of firemen is always kept in readiness, the men can go to the indicator alarm box immediately after receiving the alarm. However, if there is in addition a volunteer fire department or, in fact, only such exists, they must be informed upon receiving the alarm. This can be done in many ways by means of steam whistles, fog-horns and bells. In modern systems, however, a public general alarm is generally avoided, as it causes unnecessary excitement, particularly at night. Hence, *preference is given to the so-called private alarm*, i e., alarm arrangements, which, at the breaking out of a fire, summon only those persons who belong to the fire fighting forces.

It is maintained that for private signals for the firemen the use of alternating current alarm bells is best suited, the bells being put in the homes of the firemen If the bells are connected in separate alarm lines, they must be connected in a closed circuit. The current steadily flowing through the circuit does not affect the alarm bells To ring them the necessary alternating current must first be generated at the central station This is done simply by turning the crank of a magneto As the bells ring only so long as the magneto is being turned, it is possible to give various signals by varying the turning of the magneto crank handle.

It is stated that about 30 alarm bells can be rung at the same time by the magneto As soon as more bells are to be added, the fire-alarm box circuit, by leading back to the central station several times, can be divided into a number of alarm bell loops Each of these alarm bell loops has its contact key on the magneto The individual alarm bell loops, *in each of which there may be up to 30 bells*, are operated simultaneously but one circuit after another This subdivision into several alarm bell sections has the advantage of notifying only those located in that section in which the sending alarm box is, and then later the others, if the men already at the fire are not sufficient.

Usually the magneto, together with the indicator apparatus, is mounted on a wall switchboard, on which there are also placed the auxiliary apparatus, including the lightning protectors, which protect the sensitive parts of *the receiving apparatus not only against lightning strokes* which directly strike the overhead wires, but also against weaker atmospheric discharges and against heavy current discharges in case the overhead lines come in contact with street car or other power circuits

There is also in some instances on the board a list of the alarm box numbers with their respective locations, directions for the operators and two bells which ring during an alarm, for the control of the signals sent off If there are two indicator apparatus, a similar board is used in larger installations having three or more indicator apparatus, *correspondingly larger switchboards are used*

The battery cells necessary for operating the system are also placed at the central station in a locked closet or cabinet For generating the direct current in the box circuits, closed circuit cells are used these having an electrolyte of copper sulphate; they are recharged about two or three times each year For controlling the battery an ammeter is provided in the indicator apparatus, which shows the current flowing through the line

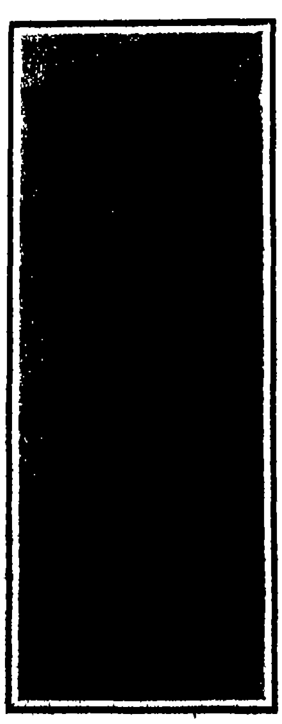


FIG. 3.—MASTER CLOCK

in the local or annunciator circuit Leclanche or dry cells are used.

As indicated in the illustration the switchboard and the battery cabinet together constitute the complete central station of a fire alarm system and are easily installed

In case electric power is available in the city, small storage batteries are used instead of the primary cells. The storage batteries, if small in number, are placed in closets provided with a chimney to allow the gases which develop to exhale, or in larger installations are put in the cellar on stands of several tiers. Operation with storage batteries is more convenient and cleaner The cost is greater, but the operating expenses are lower with primary cells. The switchboard required for the monthly charging of the storage batteries, is very simple and can be operated by inexperienced persons.

Fitness in Machine Design

IT is commonplace that, in the design of any new machine, or structure, the relative proportions of the various parts, and their positions in relation to each other, are determined rather from precedent and experience than by calculation Certainly, in simple cases calculation may be employed, and is employed thus, for instance the

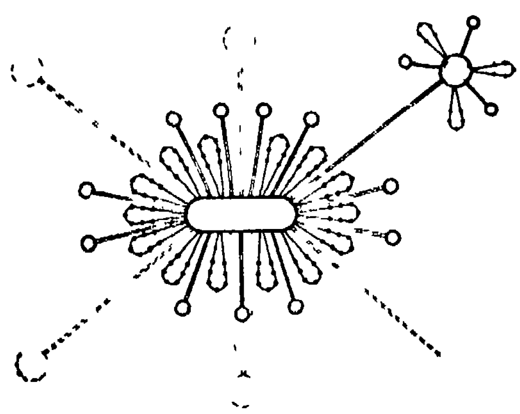


FIG 4—CIRCUITS CONNECTING THE ALARM BOXES

dimensions of a simple tension member of a bridge may be directly determined from the known properties of the material from which it is to be made although even in this case, the factor of safety to be employed is fixed in terms of precedent and experience alone In general in simple structures, a mathematical determination of the dimensions of parts may be employed but as they tend to become more complicated the reliance on precedent and judgment becomes ever greater In the design

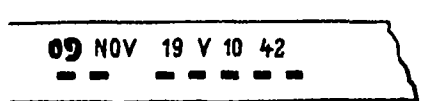


FIG 5—REGISTER ON TAPE

of machines this reliance on personal judgment becomes still more noticeable Even here, however some few leading dimensions may more or less, be determined mathematically the diameters of shafts and the sizes of bearings may for instance be so fixed although these will frequently be modified by a designer in order to bring them into what he considers better relation to the general arrangement and dimensions of a machine which are of

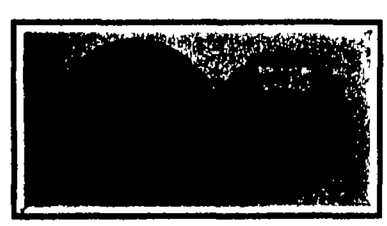


FIG 9—ALARM BOX OF SMALL CITY

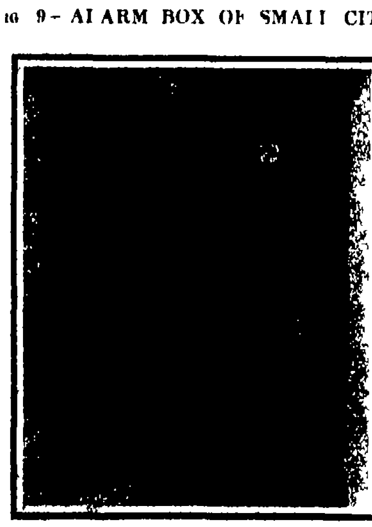


FIG 10.—ALARM BOX FOR LARGER CITIES

course, a function of the operation it is intended to perform. Allowing, however, for cases in which calculation is of assistance in general, it may be said that the determination of the dimensions of machine parts is a process depending rather on experience and individual judgment than on mathematical considerations

The ability to determine instinctively the correct dimensions for a machine part which is to be subjected to indeterminate stresses is a common enough feature among machine-designers. All competent draughtsmen have it in greater or less degree It has even received a name, and those in whom this ability is strikingly displayed are commonly said to have a "mechanical instinct." The system on which this ability operates, and by which such instinctive designing is carried out, is worth a little attention It is common practice to sketch out roughly the general lines of a new machine on a drawing board, and to determine approximately the sizes and shapes of the main parts from this sketch, various dimensions, curves and tapers being modified in freehand until the whole begins to hang together properly and the different parts bear such relation to each other as to make the whole appear a satisfactory and workable and probably a neat machine The process is largely a visual one and although there are men capable of forming wonderful mental pictures of new machines or apparatus, even they will, in general be found more or less to modify their ideas when they see them down in black and white The dependence of this process of instinctive designing on the visibility of the object designed is a matter of some interest, and may be given a little consideration.

The fact that the mechanical instinct judges the soundness or otherwise of a design by its appearance may be interpreted by saying that such instinct is but an example of visual memory and that the eye after long training and familiarity with correct designs, retains a sort of standard with which it is capable of comparing future examples which may be presented to it. This however appears a somewhat limited statement of the case, as a sound designer is capable of correctly proportioning the parts of an entirely new form of machine or of one of a type with which he is not familiar It would probably be nearer the truth to say that the actual appearance of a machine and the general look of fitness of its various parts in relation one to another is in fact a direct measure of its efficiency as a piece of mechanism In one sense, of course this statement is a mere truism but the present idea goes further than the first obvious meaning of the sentence and suggests that the mere general appearance of a machine is, in fact, some measure of its adequacy as a machine The idea is that there are certain *more or less obscure principles of fitness or if one* prefers it of beauty to which correct design of necessity conform and that competent designers work in terms of these principles without necessarily recognizing their existence or being able to state them This idea is but a particular application of a doctrine which in one form or another has been advanced times without number in relation to the Arts the doctrine that the best and finally correct form of anything is at the same time the most satisfactory in appearance—the most beautiful This was one of Ruskin's favorite doctrines and there *would be no difficulty in finding a dozen passages in his* works illustrating it For instance: Few buildings are beautiful unless every line and column of their mass have reference to their foundation and be suggestive of its existence and strength so nothing can be beautiful in Art which does not in all its parts suggest and guide to the foundation Translating this into engineering language one may say that of two machines that will be the best mechanically which is the best in appearance and which the proportions and relations of the various parts suggest to a competent observer a proper distribution of weight and stress The classic expression of this doctrine of fitness and efficiency or beauty and truth as Ruskin would call it is due to Keats:

"Beauty is truth truth beauty—that is all
Ye know on earth and all ye need to know

FIG 7—A CITY ALARM BOX

It may appear a far cry from Keats to machine design and yet it is probable that if this doctrine is not pushed too far it will be found to have quite definite application in practice.

This matter cannot be satisfactorily discussed without a consideration of what constitutes fitness or beauty in machine design, although, by approaching the matter from this point of view there is some danger of reasoning in a circle In the early days of the development of the steam-engine and machine tools it was the prac-

tice to attempt a sort of added beauty in mechanical constructions by such devices as the provision of Corinthian pilasters on engine standards and the adornment of bridge work with various species of cast iron carving. This type of engineering art found little favor with the professed experts in artistic matters and there is an amusing story told, if our memory serves, by Sir Benjamin Baker to the effect that in his early days he had adorned one of his bridges with some type of cast iron filigree work which drew from Ruskin the remark that the sight of it always made him wish he had been born a blind fish in an underground cave, and thus escaped the pain of ever seeing it. This system of designing a machine, or structure and afterward sticking on a certain amount of external decoration endured later in the United States than in Great Britain, but although it still crops up at times it is fairly generally abandoned nowadays. We recently came across a water meter intended for irrigation or similar use which was carried on a pair of cast iron legs of floricultural design that were appropriate rather for a German beer garden than an engine room. Examples of this order are, however, rare at the present time, and whether it be as a result of criticism by engineers themselves or that of outsiders, there is no doubt that the majority of designers are now persuaded that any beauty in mechanical work must inhere rather in the lines and proportions of the design than in added matter of any description.

It may appear that a conclusion to the effect that external decoration is unsuited for mechanical constructions and that beauty in such works can be obtained only by a proper distribution of forms and proportions merely leads back in a reverse direction to the point we attempted to attain in the early part of this article. There is, however, a difference in the conclusions reached by the two ways of approaching the matter, which may perhaps be illustrated by an example. A good deal of criticism has at one time and another been directed against the Tower Bridge on the score that its ornamental features are purely extraneous, and that the masonry towers form no essential part of the design but are simply added to make the bridge look "pretty," the implication being that had the steel work been left in its nakedness without covering of any sort, the final effect would have been more beautiful. This point of view assumes, or should assume, that the steel work is of bold and straightforward design admirably suited for its purpose, and such that in it the general distribution of weights and stresses can be followed by a trained eye. This represents the anti-decoration point of view which was considered immediately above. The alternative way of looking at the matter, however, which we dealt with first, asserts that had the steel work been left bare, then the general impression of beauty which it conveyed to the eye of an engineer would actually be a measure of the mechanical adequacy of the design; and that a construction which, although satisfactory and workable enough, yet was more or less disproportionate or wasteful of material, would, for that reason, appear less beautiful and fitted for its purpose. It is clear that a full discussion of this matter would involve an inquiry into the nature of beauty but that investigation has bogged too many generations of philosophers to be attractive, and the meaning attaching to beauty or fitness, in machinery is in general, quite sufficiently understood for our purpose.

We have no wish to suggest that the idea of fitness of appearance or beauty, in a piece of engineering work being in some way consonant with its mechanical adequacy is capable of anything more than very general and loose application, but none the less we think the idea will be found to have a sound foundation. It is not difficult to find examples to illustrate the matter. A very simple one has reference to the distribution of weights. A tower crane, for instance, with a revolving hammer head that is designed with such insufficient counterweight that serious and unintended stresses come on the center bearing will to a trained observer, look wrong at the first glance. It may take a few minutes for him to decide what is missing or what is wrong in the relative proportions of the parts; but he will at once see that there is a defect somewhere. The crane will look wrong and the suggestion is that it will do so because it betrays certain principles of fitness which are essential in a machine if it is to look right. Another example which may be quoted is the case of a heavy machine tool in which the legs are so light that excessive vibration is bound to be set up when the tool is operated. In this case, again, the machine would look wrong at first sight, to a trained man, simply because its design would be at variance with principles of correct construction, which are a part, possibly an unconscious part, of the observer's mental equipment. There is no need to multiply examples to illustrate this idea, but, it may be pointed out, that even such small matters as the *rounding-off of the edges of castings appear to be* consonant with the "beauty is truth" doctrine. Square-edged castings not only look wrong, but are wrong. A fine example, which is of some interest, may be mentioned. We believe attention has been drawn to it by Mr. Lanchester. It has reference to the position of the steering hand wheels of motor cars. In the early days it was the practice to carry such hand wheels on vertical spindles, so that they lay in a horizontal position; while at the present time it has become practically universal custom to incline the spindle toward the driver's seat, so that the hand wheel also occupies an inclined position, which in high-speed cars usually approximates to about 45 deg. from the vertical.

This change has come about partly as a result of the increase of the length of the cars; but the question of appearance has also had weight, and there is no doubt that not only designers, but the general public also, consider the inclined position the most fitting and the most in keeping with the lines of the car. One obvious reason for this is that the inclined position of the spindle adds to the impression of speed which is rightly inherent in the build of motor cars, especially heavily powered ones. It is interesting that this change, which is in every way sanctioned by æsthetic considerations, is directly substantiated by mechanical ones. With a steering hand wheel in a horizontal position, the effect of the inertia of the body of the driver, when the car is rounding a curve, is to tend to make him move the wheel farther round than he intends, so that defective steering results. This point is of much importance in high-speed cars. As the steering wheel approaches more nearly to a vertical position this inertia effect is more and more eliminated, so that the inclined wheel not only looks better, but is actually mechanically better, as conducing to easier and more accurate steering.—*Engineering.*

Value of Illuminating Engineering to the Manufacturer*

A New Art and Its Possibilities

By V. R. Lansingh

The different classes of manufacturers who are engaged in supplying things necessary for artificial lighting and who are directly benefited by the subject of illuminating engineering may be roughtly classified as follows:

A. The manufacturer of artificial illuminants.

B. The manufacturer of shades and reflectors.

C. The manufacturer of appliances used with artificial lighting.

D. The manufacturer of contributing apparatus, that is to say, apparatus which is necessary finally to produce artificial light.

E. The manufacturer of electricity or gas; for example, the central station or the gas plant. This last class is covered in convention papers by Messrs. Serrill and Gilchrist and consequently will not be considered here.

Taking up the first class; namely, the manufacturer of illuminants, this can be divided into four sections, namely, electric, gas, acetylene, gasoline. In the scope of this paper it will not be necessary to analyze the value of each of these divisions separately, but they can be considered as a whole.

A. BENEFITS TO THE MANUFACTURER OF ILLUMINANTS.

The products put out by the manufacturer will be used more correctly and consequently will give better satisfaction, which will lead to their wider use.

By a knowledge of illuminating engineering new fields for the manufacturer will be opened up.

A knowledge of illuminating engineering will teach the consumer to choose correctly the character of illuminant desirable for the work in hand which will lead to a wider extension of such illuminant for such work.

Illuminating engineering improves the quality of the manufacturers' product.

Illuminating engineering teaches the salesman of the manufacturer to solicit business intelligently, placing him in a decidedly advantageous position over his competitor who has not this knowledge.

It puts the manufacturer employing such methods above his competitors not employing them, making it, therefore, more easy to sell his goods.

These advantages may well be discussed more in detail. One of the greatest complaints of the manufacturer of illuminants is that the public does not use his product as it is intended to be used, and consequently the customer does not get the satisfaction which he was led to expect from the manufacturer's statement. Thus in the case of the incandescent electric lamp, the customer orders a lamp of 110 volts when perhaps he should have ordered one for a 105-volt circuit. The result is dissatisfaction and results in the loss of future business to the manufacturer supplying the lamps. In the case of the yellow flaming arc lamp it is sometimes seen in front of a store window where the storekeeper is attempting to show color values. The bad results consequently obtained may lead to the condemnation of the lamp simply because it was used in the wrong place. A notable example of this was the use of the mercury vapor lamp in its early days in many places where it should not have been employed with the consequent condemnation of the lamp which greatly retarded its introduction in such places where it was entirely suitable. Similar examples might be cited in other fields, but those given will probably make the point clear.

It is self-evident that a knowledge of illuminating engineering opens up new fields which heretofore were unavailable. For example in automobile head lamps the field was almost entirely in the hands of the acetylene industry until by the introduction of illuminating engineering principles (illuminating engineering is here used in its broadest sense) the manufacturer of electric appliances has been able to compete successfully. This condition required a thorough knowledge on the part of the manufacturer not only of the manufacture of a suitable lamp and the proper length, shape and position of its filament, but also the use of it in conjunction with the proper reflector with an adjustable method of focusing. Had not all of these combinations been properly employed the field would have been closed to the manufacturer of the incandescent electric lamp. It is exactly along similar lines that the acetylene industry has gained such a hold in automobile lighting as compared with the lighting by means of oil lamps first employed and still adopted on many automobiles.

In the industrial field it is found that knowledge of illuminating engineering is of the utmost importance to the manufacturer of electric illuminants, as is evidenced by the fact that one interest has devoted some $50,000 toward making investigation as to the requirements and the methods of solving the problem of industrial lighting. Before the manufacturer can hope to invade such fields he must make a thorough study of all the conditions, such as the placing of the units, the size of the lamp, the height above the floor, the color of the light, and many other problems which can only be solved by a thorough study. Examples of the benefits to be derived by the manufacturer in the study of these problems might be multiplied many times, but one other example will suffice. In the field of street lighting the old open direct-current arc lamp giving the maximum candle-power at 45 degrees was almost universally employed in the early days of electric street lighting. A careful study of the problem showed that these lamps were far from being ideal for street lighting, and a thorough study of the problem, which is still being continued, has shown that illuminants of different characteristics are desirable, and there has therefore been introduced for such work the inclosed arc, the magnetic arc, the flaming arc, as well as different forms of incandescent electric illuminants. In the case of gas street lighting, the old open flame burner has been almost entirely superseded by the mantle burner, either singly or in clusters, as for example the high power high-pressure incandescent gas mantles used for lighting many of the cities of England and the Continent. It was only by a knowledge of the distribution and character of the light that the manufacturer has been able to introduce his product against the competition of the older and more firmly established illuminants.

A knowledge of illuminating engineering improves the quality of the manufacturers' product. The manufacturer who would improve his product calls to his aid many of the different branches of illuminating engineering, using this term in its broadest sense. He calls upon the chemist, the physicist, the glass maker, the shop process man, the selling organization for their experience in things desirable and by means of all of these the product is gradually raised in quality, due to the wider knowledge of illuminating engineering. For example, in this country the quality of the incandescent carbon lamp has gradually been raised so that to-day a lamp of from 2.5 to 3 watts per candle is obtainable, where formerly for the same length of life a consumption of from 3 to 3.5 and even 4 watts per candle was necessary; while in England, where little is as yet known of illuminating engineering, and where commercial methods have not the same tendency to advance it as they do here, the lamps reach as high as 8 or even 10 watts per candle, resulting most disastrously to the introduction of electric light in competition with gas. Summing up, therefore, it may be safely stated that one of the greatest values of illuminating engineering to the manufacturer is the resultant improvement in the quality of the illuminants he makes.

It teaches the salesman to solicit business intelligently, and a salesman equipped with a knowledge of illuminating engineering cannot be placed in the same class as one without this knowledge. This is so well recognised to-day that the trained illuminating engineers who also have selling ability command the higher salaries and are of far greater value to the manufacturer than those without this knowledge. This condition is so rapidly increasing that with the growing knowledge of illuminating engineering among the buying public, the companies whose salesmen have been best educated in illuminating engineering are those who are making most rapid progress.

In a like manner it puts the manufacturer using illuminating engineering above his competitors who are not employing such methods, for the manufacturer is, after all, nothing but a salesman, and what is true of the salesman is also true of the manufacturer. This is well evidenced by the recent rapid progress made by the manufacturers of incandescent electric and gas illuminants who have made illuminating engineering departments part of their regular organisation.

B. BENEFITS TO THE MANUFACTURER OF SHADES AND REFLECTORS.

To the manufacturer of ordinary glass shades which are designed primarily for decorative or diffusing purposes, a knowledge of illuminating engineering is of value. As an example can be taken the question of the color of illuminants and its relation to the glassware

* A paper presented at the Fourth Annual Convention of the Illuminating Engineering Society, Baltimore, October 24 and 25, 1910.

used. Thus if a glass manufacturer wished to obtain a glass for home lighting which would give a warm color to the eye, but at the minimum loss of absorption, he would employ a different glass for tungsten lamps from that he would use with carbon, since in the latter case it is not necessary to employ as much color as in the former. Similar examples of the value of illuminating engineering to other branches of ordinary decorative glassware might be easily multiplied, especially in the physiological and psychological effects it is desired to produce.

In discussing, however, the subject of reflectors, it is at once evident that a thorough knowledge of illuminating engineering, not only in its broadest sense but in its more narrow and usual application, must be employed. Thus, in the case of prismatic reflectors, there are all sorts of candle-power distributions which have been obtained to fit different conditions, as for example the so called "extensive" "intensive" and "focusing" forms of distribution, all of which have been designed to fulfill lighting conditions which it would have been impossible to produce or even know the requirements of without a proper knowledge of illuminating engineering. In fact such glassware is, as a rule, designed after the requirements have first been laid down in accordance with the principles of illuminating engineering. It is self-evident that new fields are being opened up from time to time by a study of the requirements through the aid of illuminating engineering. The same careful work is not only being done in the case of prismatic reflectors but also with other types; for example in the case of a type of reflector designed to give a symmetrical distribution throwing the light up and down the street which was designed after a study of the requirements had shown the necessity for a very broad candle power distribution in which the flux of light was largely confined to the street rather than spread uniformly into surrounding space. In the case of indirect lighting there is another example where by careful design distribution curves have been obtained which will give maximum efficiency for this system of lighting. As a matter of fact, the proper design of reflectors could hardly be said to exist were it not for a proper knowledge of illuminating engineering and these two must of necessity go hand in hand. It is for this reason probably that the manufacturers of shades and reflectors were the first to recognize the value of illuminating engineering, and they have done all in their power to spread the art among the public as well as among those directly interested.

C VALUE TO THE MANUFACTURER OF APPLIANCES.

Under this heading can be included all those devices which are directly applicable to the illuminants themselves. Thus, there are the fixtures used to support the illuminants and their shades or reflectors, the burners in connection with mantle gas lighting; the sockets for electric lamps; the tips for open gas and acetylene lighting, as well as numerous other appliances. The fixture manufacturer has been generally speaking slow to recognize the value of illuminating engineering as applied to his art; but to-day the most progressive houses are recognizing its value and are accordingly taking advantage of it much to their financial benefit especially in commercial lighting. The lighting of a great majority of stores office buildings and other commercial places is to-day being done by units which are properly supported by fixtures designed to give definite results. This is equally true of both gas and electricity. The result has been that within the last five years the types of fixtures for lighting such buildings and places have been entirely revolutionized and those manufacturers who do not take advantage of the knowledge of illuminating engineering necessary to obtain the desired results must of necessity fall behind in the race. Even in the case of more decorative plans where efficiency is of secondary consideration a knowledge of illuminating engineering is beginning to tell. In the home to-day for example the educated customer is beginning to insist that his house shall not only be properly lighted from an artistic standpoint, but also from an economical and physiological standpoint and the manufacturer who can take advantage of these conditions is the one who will get the business. It will therefore be evident that a knowledge of illuminating engineering in the proper design of fixtures to fit the conditions at hand is also of value.

In the case of burners for mantle gas lamps the question of price is of secondary consideration. This is evidenced by the fact that the majority of the business of the country for this line is controlled by one company; this is due to the quality of its apparatus rather than a question of price. Such burners being designed along scientific lines and with the ideas of illuminating engineering used in its broad sense have become standard for this class of work throughout the country. The fact that the company above mentioned is employing illuminating engineering methods and is the foremost one in the gas field fully bears out the point mentioned.

A similar line of argument might be used in the case of acetylene burners, sockets and other material directly used in support of illuminants; but sufficient has been given here for the purposes in hand.

D VALUE TO THE MANUFACTURER OF CONTRIBUTING APPARATUS

The value to this class of manufacturers is indirect rather than direct but that its value is great no one would deny. Thus in the incandescent electric lamp field the extension during the past few years into new fields has been tremendous all of which means a larger demand for apparatus of all kinds. The manufacturer of the electric generator the steam boiler and all the other necessary parts to a generating station conduits, wire porcelain and all the appliances necessary for the distribution of electrical energy have been greatly benefited by the large increase in the use of electric energy by reason of a more thorough appreciation of its advantages by the public which have been largely caused by the correct use due to a knowledge of illuminating engineering either on the part of the customer or those responsible for the sale of the illuminants. That this is of great practical value is recognized by the great electrical jobbing fraternity of the country who when asked by a prominent manufacturer whether they would rather have a larger margin of profit and have the educational work in illuminating engineering by the manufacturer cease or have their present margin of profit with the educational work in illuminating engineering continued stated that owing to the large increase in sales of contributing apparatus as well as the direct illuminants and their accessories they would much prefer to have the missionary work in illuminating engineering continued.

CONCLUSIONS

It is seen from the examples cited above that illuminating engineering is of great benefit to the manufacturer of all sorts of apparatus used in connection with artificial lighting either directly or indirectly and the fact that large sums of money are being spent to further the knowledge of illuminating engineering is ample evidence of the correctness of this statement.

RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR EDWIN GOULD

1 A PRIZE of $15 000 has been offered by Mr Edwin Gould for the most perfect and practicable heavier than air flying machine designed and demonstrated in this country and equipped with two or more complete power plants (separate motors and propellers) so connected that any power plant may be operated independently or that they may be used together.

CONDITIONS OF ENTRY

2 Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines in which the arrangement of the engines and propellers is clearly shown with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize 361 Broadway New York city. Each contestant in formally entering his machine must specify its type (monoplane biplane helicopter etc) give its principal dimensions the number and sizes of its motors and propellers, its horse power fuel-carrying capacity and the nature of its steering and controlling devices.

3 Entries must be received at the office of the Scientific American on or before June 1st 1911. Contests will take place July 4th, 1911 and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE

4 The committee will consist of a representative of the Scientific American, a representative of the Aero Club of America and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST

5 Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control, and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6 All heavier than air machines of any type what ever—aeroplanes helicopters ornithopters etc—shall be entitled to compete for the prize but all machines carrying a balloon or gas containing envelope for purposes of support are excluded from the competition.

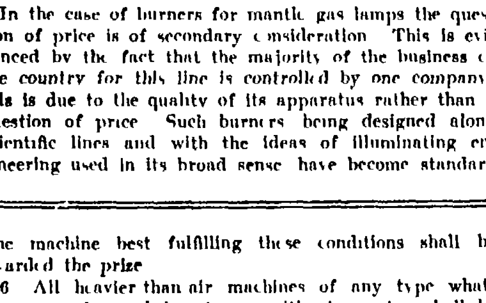
7 The flights will be made under reasonable conditions of weather. The judges will at their discretion order the flights to begin at any time they may see fit provided they consider the weather conditions sufficiently favorable.

8 No entry fee will be charged but the contestant must pay for the transportation of his machine to and from the field of trial.

9 The place of holding the trial shall be determined by the Contest Committee and the location of such place of trial shall be announced on or about June 1st 1911.

Sensitive Indicating Micrometer

The accompanying illustration shows a micrometer. The object of this tool is to avoid dependence on the sense of touch of the person handling the measuring tool. In the instrument shown the accuracy of the reading is independent of the sense of touch or experience of the operator, and a correct reading can be easily detected by the eye by means of an indicator. The principle of the device is simply this: The stationary member or anvil A is attached to a circular diaphragm B which is supported on its circumference in the head C. This head is cut away so as to form a cone shaped depression which, in connection with the diaphragm, forms a receptacle for mercury. The head C is provided with a stem, which fits into a bearing in the micrometer frame, and is slightly adjustable. A capillary tube D is partially imbedded in the frame, and has one end screwed to the stem of C by means of a collar E. An adjustable scale F is arranged at the center of the frame. When measuring the object to be measured will be pressed against the anvil A until the mercury in the tube reaches zero graduation on the scale F. For every piece measured the micrometer screw will be screwed down until the pressure on the anvil equals the standard pressure required for the mercury to indicate at zero on the scale. The tube of course must be made of glass so as to make the mercury column inside visible to the eye. It is evident that very close measurements can be obtained in this way. One objection to the instrument may be that it must be held in a vertical or nearly vertical position when in use. The principle involved however may possibly be used for other micrometer measuring instruments where the dependence on the sense of touch is objectionable.—*Machinery*



SENSITIVE INDICATING MICROMETER

Invisible Phosphorescence

ULTRA VIOLET phosphorescence first observed in fluor spar soon after the discovery of the Roentgen rays has since been detected in a great many substances. Pauli has recently discovered infra red phosphorescence in the sulphides of the alkaline earth metals. In Pauli's experiments the infra red as well as the ultra violet bands of phosphorescence were fixed by photography. A Lenard spark phosphoroscope was employed to produce phosphorescence in the substance which was placed in a quartz vessel before the slit of a spectroscopic camera. An exposure of 30 minutes usually sufficed for the ultra violet bands. The places of these bands in the spectrum were fixed by photographing the spark spectrum of zinc beneath the spectrum of the phosphorescent substance and the positions of maximum intensity were deduced from the sensitiveness of the plate for different wave lengths.

It was far more difficult to photograph the infra red bands owing to their extreme weakness and the small sensibility of the plate to infra red rays. The exposure usually continued ten hours, and often from thirty to fifty hours. The plates were sensitized with decyanine alone or mixed with cyanine. The positions of the maxima of the infra red bands were determined by photographing the line spectra of lithium and potassium and the continuous spectrum of a source of known distribution of energy according to wave length (the Hefner lamp) beneath the phosphorescent spectrum.

Phosphorescent bodies containing calcium sulphide show the most numerous ultra violet bands strontium compounds a smaller number and barium compounds none at all. These bands seldom extend beyond the wave-length 300$\mu\mu$ (millionths of a millimeter) and their position is independent of the method by which the phosphorescence is excited. Certain substances when very strongly excited by cathode rays emit momentarily radiations which extend very far in the ultra violet, to the wave lengths which are absorbed by the atmosphere.

Infra red phosphorescence is a much rarer phenomenon which Pauli has observed in only four substances. The phosphorescence exhibited by a fluoride of calcium and nickel extended farthest in the infra red region, to about 915$\mu\mu$. In all cases the infra red phosphorescence is very short lived, owing to the extinguishing effect of the infra red rays. The ultra violet phosphorescence is much more persistent.

Pauli's discoveries give support to Lenard's theory that the remarkable displacement toward the red which is produced in the bands of calcium strontium and barium sulphides by the addition of a heavy metal is due to electric oscillations in the atom of the last.—*La Nature*

A Spanish Mining Concrete Pier

A Remarkable Cement Structure at Guadalquivir

By Frank C Perkins

The constru t on of the Guadalquivir concrete pier for the Spa ish mine Aznal Collar is shown in the accom panying illust ati s and d agran s and was the work f tl e Compa i Caditana de Minas The electrically operated cra e, whi h served the vessels employed in the b ild ng of he p e s how in Fig 1

Tl reinfo ed on e e p er measures 162 5 meters (533 1 f) leng h and 5 3 meters (17 4 feet) in w ith p o of tl e pier 51 n eters (167 3 feet) long l g a r e hav ng a radius of 100 meters (328 1

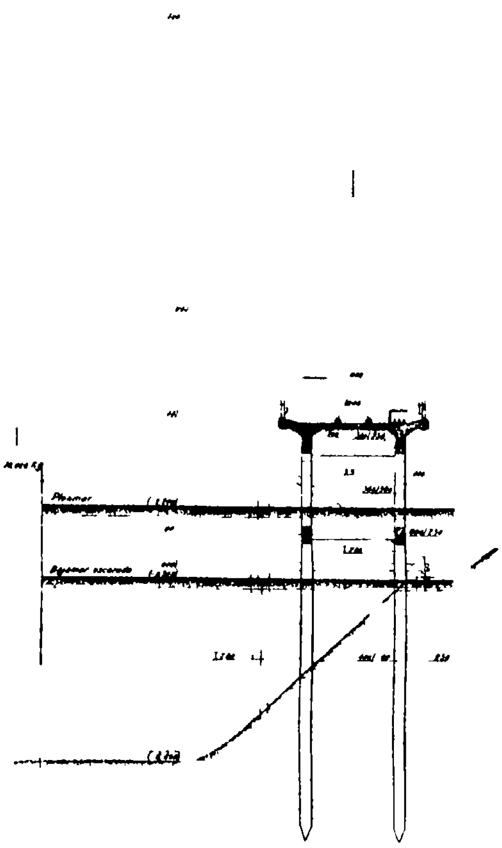


FIG 3 DIAGRAM SH W N F ARRANGE ENT OF E E TR CRANE

feet) as indicated in the plan (Fig 2) the remainder of the pier 11 5 meters (37 7 feet) in length, being straight and served by a track of one meter (3.28 feet) gage, on which the locomotive and cranes are transported under the portal of the traveling crane.

The diagram, Fig 3, shows the arrangement of this electric crane as indicated in illustration Fig 1 designed to travel on a track, the rails being 5 meters (16 4 feet) apart and installed on the outer edges of the concrete structure The current is conveyed to the crane motors by three live rails or conductors as seen in Fig 1; the power being supplied to a sub-station on the pier structure and connected with an electric power transmission line supplying current from the mining generating station The crane has a capacity of 10 000 kilogrammes (22 046 pounds) when lifting a load with a radius of 12 n eters (39 4 feet)

The nethod of driving the concrete pile is shown in the front page illustration a portable steam boiler and hoist being provided on the scaffolding and a steam l ammer being utilized for driving the concrete pile. The ill stration Fig 5 shows the breaking of a reinforced concrete pile 19¾ inches square while under test and showing a remarkable resisting power and great strength These concrete piles were driven 3 3 meters (10 8 feet) apart as seen in drawing Fig 3 which shows the high water level as well as the lowest water level and the depth of the Gua lalquivir River adjacent to the rein forced concrete pile This concrete structure was designed and constru ted nder the directions of Juan Ma uel de Zafra an engineer of Madrid Spain and professor of Reinforced Concrete Construction" and of Harbors and Coast Lighting' at the engineering institu t n Esc ela Especial del C erpo

M Ph. Berger recently communicated to the Aca demie des Inscriptions a Jewish manuscript obtained by the Pelliot expedition, which is one of the most a ient we possess It is a prayer made up of passages taken from the Psalms or Prophets, written in good Hebrew characters of the square type with a still indimentary vowel notation. The leaf is folded upon itself and is intended to be carried by the owner Paris archæologists pronounce it to be of the eighth or ninth century A. D It has a great resemblance to the Hebro-Persian manuscript which M Stein brought from east Turkestan of about the same epoch. The manuscript has some noteworthy points which are now being studied.

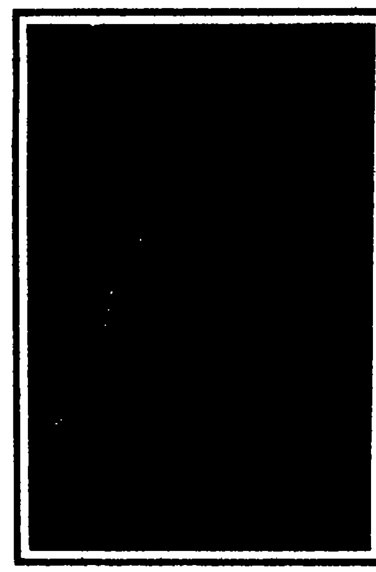


FIG 5—OPERATION OF TEST FOR BREAK NG REINFORCED CONCRETE PILE

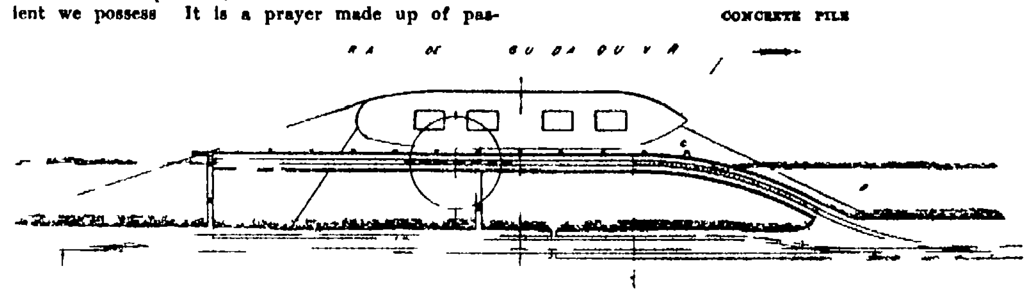


FIG 2 LAN OF THE RE NFORCED CONCRETE PIER SHOWING TRACK CURVE ETC

FIG 1—ELECTR CALLY OPERATED CRANE EMPLOYED IN CONSTRUCTION OF SPANISH CONCRETE PIER

A SPANISH MINING CONCRETE PIER

Blue-Printing by Machinery

A Collection of Interesting Contrivances

By George J Jones

In the days before the general introduction of the blue-print, it was necessary to keep the plans and drawings of a structure or engineering project in an office or a shanty erected for the purpose The superintendents and workmen were obliged to familiarise themselves w th the plans as far as possible and whenever a doubt or question arose, it was necessary to interrupt the work wl ile an excursion was made to the place where the drawings could be consulted Under the old order of things a duplicate set of drawings represented such an outlay that it was not to be considered u less i nperatively de manded At present however beca se of the introduct on of the blue print almost every work nan can have a set of draw ngs at h s elbow In fact about machine shops a d similar establishments, t is the present cu tom to s pply copies of the original drawi gs to all workmen engaged on the job In this manner the work of con struction has been greatly facilitated

The blue-print was not long in working its way into popular favor However as these prints were exclusively made by the s n a spell of bad weather ser ously inter fere l with the work of turn ng out the pr nts thereby delayi g i nportant engineering or architectural projects d pendent on the delivery of the pr nts

Recently electricity has l een used for n aking these prints irrespective of weather conditions and there are ow several machines with which the printing is carried o almost a tomatically by artificial light.

One of these blue-pr nting machines which we illustrate herewith, not only does the printing but also washes and dries the prints running water being ut lised for the washing and the drying being done with gas or steam This machine is operated by a small electric motor It is designed to operate on an incandescent electric circuit supplying 110 or 220 volts direct urrent or 104 volt alternating current. It is said to be able to give 5,000 square feet of blue-printing per day Continuous prints can be made, of any length, with stop or readj istme t. The sensitised paper and tracing are fed in at one en l of the machine like a printing press and the print and tracing fall into a dark box at the other end The ten sion or pressure is automatic and does not depend on the operator, the contact being perfect.

The operation of the machine is exceedingly simple The roll of blue-print paper used passes with the tracing over the printer and is printed by a light from five electric arc lamps The tracing automatically drops off and the paper continues under the board into the wash ing trough and under the roller then passing upward A constant spray of water is throw over the surface of the paper at this point and runs o er the entire sur face The paper then passes between squeegee rollers to a roller at the top of the macl i e, thence it is stretched over a series of rollers and dried before being finally wound up on a roller provi led for that p rpose A gas or steam heater supplies sufficient heat to dry the paper perfectly Separate pr nts n ay also be washed an l lri l as easily as a continuo s length

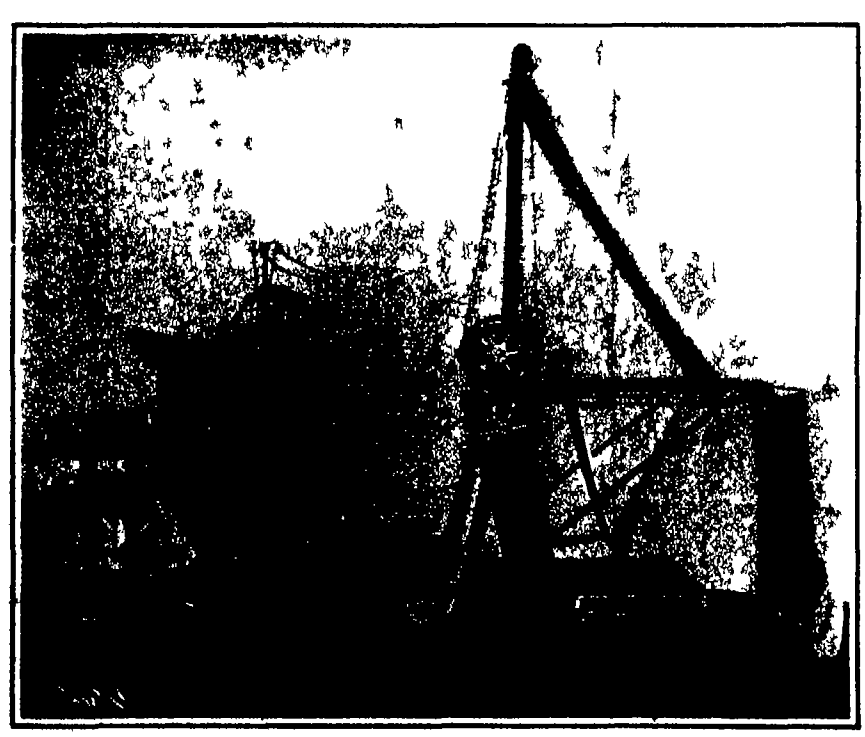
The machine s supp l ed w th from three to five elect c lamps which are suspe ded in such a manner that the light from then falls directly upon tl e sensitised paper and tracing cloth as they pass The print is th s auto matically made without any nanipulat on on the pa t of the operator An electric motor moves tl e co t uou bands whicl carry the sensitised paper and tra ngs front of the lamp being on the san e circuit as tl e l p A double c ne speed cl nging me hanism is sed to change the speed

We also illustrate another machine which l nd j t l to take individual pri ts as they emerge from the pr nt ng machine an l put them through the finisl ing stages without any handling whatever It dispenses w th the slo nd splash wh ch resulted from the nanipulation of the prints by the old system The prints are washed l y a number of small streams of water directed upon the sensitised side of the paper only as the sheet hangs over a rod. Thus the paper is not saturated as it is in the bath, but the ferro-prussiate is just as thoroughly car- r e l off The sheet is left under these streams until the l sequent one is taken from the printing fra ne and en it is moved along automatically and the new sheet takes ts pl ce ut der the jets Tl e wasl ed print pro- g es es to a w p ng de ce whi h rn es the s rplus water fro he no stened s face S on tl e drying rod on wh h t was origin lly pla e l t s p a sed to a pa r of r ol g h ns wl l t k p l o l d ts l urd n an l rry it slowly pwar l th o gl a c rr t of warm air l h is it is passed over and b k an l fi lly finds its way to a rack in the rear of the mach e where the sheets hang separated from one another by a space of several inches, to permit thorough drying

A DOUBLE BLUE PRINT MACHINE

BLUE PRINT WASHING AND DRYING MACHINE

THE WIPER OF THE BLUE-PRINT MACHINE



MACHINE FOR PRINTING WASHING AND DRYING BLUE PRINTS

An Appreciation of Thomas Davenport*

A Pioneer in Electrical Engineering

By T Commerford Martin

A NATION that spends as much every year for electricity as for daily bread may well entertain sentiments of reverence toward its pioneers in the electrical arts That part of our country which has given birth to some of the most notable of these pioneers may also well exhibit special pride in the fact and signalize it in appropriate manner It is indeed noteworthy that New England has to her credit a wonderful list of electrical worthies and through them has forever set deep and imperishable a stamp on American invention and industry as distinctive and unmistakable as the imprint of her poets in literature and her statesmen in politics No other geographic division blends these merits in equal degree with New England To Massachusetts as natives of Boston we owe Benjamin Franklin who snatched the lightning from the clouds and Morse who as father of the telegraph, made the lightnings talk To her also we owe Cyrus Field the great creator of submarine cables and his brilliant nephew the electric dynamo and railway pioneer, Stephen D Field both natives of Stockbridge From North Adams also came Frank Julian Sprague to whom more than any other living man is due our preeminence in the art and industry of electric traction on railroads and of electric elevators in buildings To the Wallace family of Ansonia Connecticut we are indebted for the development of our electrical wires and cables and for the production of our first lighting dynamos and arc lamps From Boscawen in New Hampshire came Moses Gerrish Farmer inventor and founder of the modern fire alarm system and original discoverer of the modern self exciting dynamo principle so fundamental in all our work And while neither Edison nor Bell was a native New Englander it was in Boston that Edison made and patented his first invention and in Boston that Bell gave to the world the telephone and the art of electrical speech transmission At Lynn for a quarter of a century also Elihu Thomson has been producing with lavish genius one beautiful invention after another in electric light power heat and measurement

Only yesterday, I received a letter from Randolph Vermont, from Mr A B Chandler President of the Postal Telegraph system informing me that he is a native of this state This veteran has been the successful organizer of the only competing telegraph system that ever survived in the United States while he and Charles A Tinker another Vermonter and one of the chiefs of the Western Union system were President Lincoln's confidential telegraphers at the White House during the whole Civil War There were four such men and it is singular to say the least that two of them should have been Green Mountain Boys

This is surely a noble record of illustrious names and rich achievements well distributed among sister states but my special duty and honor is to add thereto with emphasis in this region where he lived and dreamed and suffered and wrought the name of Thomas Davenport of Brandon Vermont the first American patentee and builder of the electric motor; the first man in all time to apply electric power to the operation of railways the first man in the world to hitch together those two tremendous forces electricity and the printing press Seen from the industrial standpoint it is significant that his patent if enforced to-day would embrace every one of the millions of electric motors now in service in the United States whose royalties would constitute an income equal to anything enjoyed by Rockefeller or Carnegie That we have escaped such a gigantic monopoly is something on which we and perhaps even the descendants of Davenport are to be congratulated but it would have been a merciful dispensation if the bitter bread of struggle and disaster eaten all the years of his short life by this extraordinary genius this prophetic village blacksmith could have been sweetened with the merest modicum of the vast wealth that his glowing conceptions have helped to create for the benefit of us all

Thomas Davenport was born at Williamstown Orange County Vermont a descendant in direct line of the Davenport family conspicuous in the early annals of the New Haven Colony He was eighth in a family of eleven, and it may not be an impertinence to suggest that neither New England nor Vermont is likely to breed more like him until it resumes the good old habit of such large families not merely to enjoy these fair hills and pastures but to go out and conquer the world at large Thomas was only ten when his father died only fourteen when he was apprenticed to the blacksmith trade A farmer's sons in those days had to depend for education on the little red school house To day perhaps a Vermont farm boy is lucky if he finds the little red school house in existence nearby All the formal education that Davenport got was for six weeks a year for a briefly indefinite number of years in a common district school house in a remote mountain town But he did get hold of some fragmentary portions of a scientific book, and as he blew the bellows so with it he fed and fanned the fires of his intellect Meantime he lived at Forestdale then a center for a little iron industry the blast furnace being located there doubtless because of the availability of charcoal He was a slender thoughtful lad and never appears to have been in very robust health. The whole drift of his thought is indicated by the fact that having made the acquaintance of another clever young fellow named Orange A Smalley wagon builder and wheel wright he formed the ambitious plan of going from place to place to deliver experimental scientific lectures The question of apparatus came up, and very naturally into the discussion came the wonderful "galvanic magnet" of Joseph Henry in operation at the Penfield Iron Works at Crown Point, only twenty miles away for sifting magnetic iron ore This magnet it was rumored would hold up a blacksmith's anvil, like Mahomet's Coffin between heaven and earth and Davenport determined to see it and get one During the intervening years the peripatetic lecture scheme seems to have been wholly abandoned a reason being found in his settlement at Brandon in 1823 as an independent working blacksmith and his marriage in 1827 to Emily Goss of that town, a beautiful girl of seventeen, granddaughter of the famous American traveler and explorer Jonathan Carver Under such stimulus he worked hard at his trade, prospered and built himself a brick house He was altogether in a fair way to accumulate a comfortable property for he was intelligent, sober upright, diligent but electro magnetism was his undoing We might almost call it malicious electro-magnetism" Going to the Penfield works in 1833 with $18 to buy iron for his business he spent the money there instead in part payment for an electro-magnet and batteries The iron was needed at the shop, but how much more he needed that magnet! We must even yet extend our retrospective sympathy to the Vermonters with wagons and buggies at his door then awaiting treatment. But shall we pity Davenport putting behind him material welfare for the sake of a wild fancy? As he handled the primitive little equipment "like a flash" he says 'the thought occurred to me that here was an available power which was within the reach of man" Yes it was there, and his was the superb divination of genius to detect it. He was like another Saul hunting down his father's asses and finding a kingdom Again I ask shall we pity him, or shall we not regard him as another of those who have come out of great tribulation to attain lofty ideals?—another of the immortals selected in some mysterious way to be the leaders of the race the fire bringers?

Certainly from the materialistic point of view that magnet was a curse like those legendary possessions inflicting injury upon their fatuous owners Never again was Davenport to know peace of mind Never again were his family to enjoy a home of comfort. Indeed they were called upon to share his sacrifices It was supposed in those days that wire needed silk for insulation His brave young wife took her silk wedding gown, cut it into narrow strips and with them were wound the coils of the second motor which in October, 1835 he showed in successful operation upon the judges bench in the courtroom at Troy New York Wifely devotion could hardly go much further We are told that when Palissy the famous French potter was close upon the discovery of his beautiful enamel he used up the furniture of his home and tore down the very woodwork lining the walls to feed the fires of his kiln Madame Palissy protested and remonstrated and it is not to be urged against her that she was unreasonable But while our respectful sympathy goes forth to Madame Palissy our admiring love is won by Mrs Davenport Later on Davenport learned that silk was not so essential but that cotton wound wire would do Thus the simple machinery used to cover the wire in our grandmothers poke bonnets and crinolines was equally serviceable in the electrical arts There has always been a close and curious relationship between electricity and the sex and it is largely through such work as that of Davenport that womankind are being emancipated from all manner of domestic toil All electrical apparatus is peculiarly susceptible to female manipulation, and it is not merely because it has to do with conversation that the telephone service is to day almost entirely carried on by women

Of course the inventor had friends in all his struggles though many of them including his shrewd and kindly father in law urged him to quit and settle down to the commonplaces of life Others like the talented Smalley worked with him awhile, and then drew off One of his strongest supporters was Ransom Cook, a furniture manufacturer of Saratoga Springs, who gave Davenport for some years the aid of his purse and the assistance of his unusual mechanical ability From Professor Turner of Middlebury College; from President Eaton of the Rensselaer Polytechnic Institute, from General Van Rensselaer, of Troy; from Professor Henry, of Princeton he received generous and substantial help, all of them appreciating that this shy untutored genius had made one of the greatest advances in physics and mechanics Everywhere he got good advice and compliments but such work required more than anything else the backing of real money Going sanguinely to Washington in 1835 to secure a patent on his first motor—he had already built about a dozen—he was obliged to return home penniless his errand unaccomplished, like Mark Twain's politician who drove to the National Capital in a four in hand to get his appointment and then after months of weary waiting slunk away on foot—without it. Time and again we find Davenport playing the part of a showman glad to pick up a few casual dollars in that way; but at no time getting out of financial difficulties or planting his feet firmly on the rock of commercial success. It must have been heart-breaking, and some of his letters show how the iron entered his soul. But his work never ceased, his interest never flagged, amid all vicissitudes He remained an inventor to the end of his brief life in 1851, only 49 years of age, in the retirement of an invalid on a small farm at Salisbury, Vermont. The very year of his death he was engaged on some beautiful and successful experiments directed to producing and sustaining the vibration of piano strings by electro-magnetism, being again a pioneer in the application of electricity to music. He was also engaged throughout his life in the invention and improvement of primary batteries, devising various types of plates and solutions.

And now for a brief glance at what Davenport actually did, a review of the reasons that warrant the erection of this memorial. There is always the danger of claiming too much for an inventor of the pioneer type; there is always the temptation to read into his record that which belongs only to later years when an art has been perfected by a multitude of men and by the courageous venturing of capital on perilous enterprises When Davenport came on the scene, Faraday and Henry had already done their great work; and the principles of both the electric generator and the electric motor had been clearly perceived and enunciated Yet there were no real motors before Davenport's time, and had the dynamo then been known his work would have been carried to instant fruition Davenport and others much later than he failed of the goal because they had no ready source of cheap current, and because the double function of the motor, its reversibility, so that if operated by exterior power it would generate current, was unknown It is at least twenty times as costly to use up zinc in a battery as to get the same equivalent electrical energy from coal driving a steam pipe connected to a dynamo In Davenport's day they had not learned to convert either the energy of steam or that of the waterfalls into electric current; and thus all the electrical arts lingered and languished, except telegraphy The reason is simple Beginning at the same time as Davenport and deriving it would seem, both suggestion and inspiration from his apparatus, Morse was able to make practical the art of communicating intelligence because it took such a small amount of energy to transmit signals by dots and dashes over a wire But when Davenport told the great Joseph Henry that he proposed to build his motors up to one horse power the cautious philosopher warned him to 'go slow" and hinted that electricity could not compete with steam In Europe, Jacobi like Davenport, as early as 1834, had obtained rotary motion from electro-magnets and in 1838 at the expense of Emperor Nicholas he propelled a boat on the Neva with his motor energized from batteries Here again the demonstration failed and ceased for lack of an economical source of current There is close rivalry as to dates between the physician in Russia and the blacksmith in Vermont, but both at least encountered the same fatal obstacle the lack of cheap current So far moreover electricity has made no triumphal entry into navigation but at a time when his native State had not a single mile of steam railroad Davenport built his little model of an electric road and asserted that that was the best way to do it Had he been able to harness up any one of the adjacent water powers, he could have proved the truth of his assertion That, however, was left for our day when electricity has demonstrated its superiority in every sense, for traction

In July 1834, Davenport had built his first motor with two stationary electro-magnets and two revolving, the changes of polarity in the two sets causing attraction and repulsion, with consequent rotation thus as he says, producing a constant revolution of the wheel' We have not advanced a bit since that hour nor can we, for as Davenport wrote at the time of securing his patent, the principle of his invention "was the production of rotary motion by repeated changes of magnetic poles." If anyone can improve on the method or the description of it he is entitled to a high place in history That patent, granted February 25, 1837, first of its kind in America, was broad as a Papal Bull, and embodied this claim "The discovery here claimed and desired to be secured by letters patent consists in applying magnetic and electro-magnetic power, as a moving principle for machinery in the manner above described or in any other substantially the same in principle." Writing of Davenport's work fifty years later, in 1891, Franklin L. Pope, the leading electrical patent expert and litterateur of his day, said: "If this patent which expired in February, 1851, were in force to-day, it is not too much to say that upon a fair judicial construction of its claim, every successful electric motor now running would be embraced within its scope."

The crude motor of 1834 was soon followed by an improved form in 1835 and by many others as the years went by The motor of 1835 is interesting as being the earliest known instance of the application of the modern commutator An elastic contact-spring or brush pressed against metallic segments fixed upon a revolving shaft, so that the shifting polarity of the magnets was maintained as current was received from the battery In 1834 and 1837 motors and models were built illustrative of electric railway work, and the motor was shown to the public running on a miniature circular track 24 inches in diameter The battery was not carried by the car but was placed on a tray at the center of the circle and contact was made through mercury cups. This device embodied therefore, remotely but inevitably, the idea

* Issued by the Vermont Electrical Association

of a central station source of supply Later inventors still carried their batteries on the car, just as a storage battery car does to-day Moreover the motor field magnets and those of the armature were connected in parallel, so that at that early date we have a shunt wound motor, each core being wound twice with 24 revolutions of No. 10 wire connected in parallel. Another striking fact was that as the model itself showed, the circular track was used as the return circuit, just as every trolley car uses it to-day In 1836 his motor model filed at the Patent Office in Washington was destroyed by fire, as well as 7,000 other models; just as another Davenport motor at the Rensselaer Institute Troy was destroyed in 1862 by fire This kind of fatality pursued much of his work In 1893, the present speaker exhibited at the Chicago Columbian Exposition one of these Davenport railways, where it received an award Its exhibit was requested for the American section of the Paris Exhibition of 1900, and it was shipped early in that year with the Government exhibits on the steamer "Pauillac" Violent storms swept the Atlantic and the steamer has never been seen since In like manner disappeared the first dynamo ever placed on a ship Mr Edison equipped the Arctic exploring ship Jeannette" with a little dynamo arranged so that if necessary it could be driven by manual power "to help keep the men warm" The ill fated "Jeannette' like the 'Pauillac" now lies in ocean depths awaiting some cataclysm thousands of years hence, when men may see again these relics of their remote ancestors preserved in the museum of Eternity

Nothing daunted by fire Davenport made a third trip to Washington in 1837 and secured his memorable patent first of a long line in which the inventive genius of our people has shone forth so strikingly During the same year, Davenport and his friend Cook established themselves in New York with a laboratory and shop and gave exhibitions of their apparatus to crowds of visitors, including Morse, already busy on his telegraph and Page who 14 years later operated a battery-driven locomotive of 12 horse power on the Washington and Baltimore Railroad. In March, 1837, the partners, to raise funds for their work, organized the Electro-Magnetic Association with its stock divided into shares So far as can be ascertained this was the first electric stock company in America, first of several thousands now representing a total capitalization of ten billions of dollars in bonds and stock and earning gross over $1,200 000,000 annually The manager of the financial transactions of the partners was not, however particularly honest, and it required a chancery suit to secure an accounting, as he turned in only $1 700 out of the $12,000 received This disgusted Cook and led to his withdrawal from the enterprise As a piece of misfortune the incident was matched later about 1840 when a gentleman in Ohio proposed to join Davenport and gave him $3 000 in Ohio bank notes for an interest Davenport had spent just $10 when he learned that the bank had just broken, and that the money had become worth nothing

Davenport was not only the first man to drive a printing press by electric motor but he was the editor and publisher of the first electrical journal in the world In 1839 he gives details with regard to the operation of a rotary printing press with a motor weighing less than 100 pounds In January 1840 he began in New York City the publication of a journal which he called *The Electro Magnet and Mechanical Intelligencer* which was not only devoted to electricity but was printed by electrical energy There is evidence that a second number was issued, but it is doubtful if the periodical ran to a third number for on January 28 he wrote to his brother in Brandon about the difficulties inflicted on him by impecuniosity He had done all the editorial work himself and found that it would cost $10 per week to secure editorial articles There was no advertising and I have no way to get a few dollars except by the prospect of getting subscribers" The paper seems to have gone prematurely to its death but only a few months later on July 4th Davenport came out with another journal which he called *The Magnet* This had a real live editor salary unknown but it does not appear to have had any longer life than its predecessors Both were tiny little quarto sheets, but they were the first of their kind in America, probably first in the world and made Davenport the father of electrical journalism. Copies of both journals are preserved in the offices of the National Electric Light Association As an electrical editor of thirty years standing the speaker is proud to greet the village blacksmith as a fellow craftsman and proud again to assist in this tribute to the first of his profession in America It is interesting to note that Davenport also employed various motors to drive his printing press of the solenoid type or "axial magnet" in which reciprocating motion was obtained by the attraction and repulsion of a core within a hollow electromagnet While the principle was not altogether new with Davenport his caveat filed in 1838 with the United States Patent Office is believed to be the earliest proposal to employ the principle for industrial purposes

These are the bare outlines of a fascinating record on which one would love to linger It must be added however as an item of interest that it was proposed to develop Davenport's invention in England and that he actually took out an English patent This may or may not have been the first American invention or Yankee notion patented abroad but it was beyond any doubt the first electrical one again first of a long series It is really extraordinary how many things Davenport was the first American to do They may not have been done on the grand scale but it is not magnitude that counts What does count however crude is the conception the idea the execution of the idea in practice In all this we shall find Davenport's record astounding and unimpeachable

These then are in brief the reasons why we electricians honor Davenport and revere his memory These are the reasons why his native state and his country should be proud of him These are the reasons why struggling against adversity dying in poverty and long obscured by forgetfulness this modest simple son of Vermont stands forth as conspicuous as one of her granite mountains among the immortals who for the benefit of their fellowmen have tamed and utilized the lightnings

Magnetic Alloys

A New and Important Field of Investigation

By H A Knowlton, University of Utah

WITH respect to their magnetic properties all materials can be divided into three classes:

(1) Diamagnetic substances, such as bismuth, which, in a magnetic field set themselves with the long axis of the specimen across the lines of force and tend to move from the stronger to the weaker part of the field

(2) Weakly para magnetic substances, such as many metallic compounds and their aqueous solutions which are drawn into the strongest part of the field but do not exhibit phenomena by hysteresis or magnetic saturation

(3) Strongly para magnetic or ferro magnetic substances such as iron including those usually spoken of as magnetic which are drawn with a considerable force toward the strongest part of the magnetic field and are further distinguished from the weakly para magnetic substances by the phenomena of magnetic saturation

Besides iron the latter class includes magnetite (Fe_3O_4), pyrrhotine (Fe_7S_8), nickel, cobalt and a number of alloys some of which contain one or more of the ferro-magnetic metals, while others are composed wholly of metals which are non magnetic when pure, *i e* either diamagnetic like copper or weakly para-magnetic like manganese.

The most important example of this latter class is the so-called Heusler alloy, discovered in 1903, which consists of copper manganese and aluminium The composition by weight of a typical example may be taken as copper 65 per cent, manganese 23 per cent aluminum 12 per cent, although equally good quality may be found in samples which differ considerably in composition In any case, the manganese and aluminium should be present in approximately atomic proportions, as if more than about 25 per cent of manganese be used the alloy becomes so hard as to be unworkable The magnetic properties appear to be inherent in certain crystalline masses, not themselves the magnetic units but which contain as one of their structural elements, molecular groups that are magnetic at proper temperatures

The magnetic quality of any particular specimen depends much more upon its thermal history than upon its composition, although the maximum attainable intensity of magnetisation—*i e* the saturation value after most favorable heat treatment—depends upon the composition As is well known, iron loses its magnetic properties when heated to 785 deg C and regains them upon being cooled to a slightly lower temperature The Heusler alloys undergo a similar transformation at temperatures which range downward from 300 deg C to 0 deg C. or even lower, according to their composition When cooled below their transformation temperature in some cases the alloys are found to be nearly or quite non magnetic while in other cases their magnetic quality is greatly improved after passing through a thermal cycle These contradictory results have been shown to depend upon the manner of cooling In general, the transformation from the magnetic to the non-magnetic state takes place over a range of about 50 deg C. The effect of annealing at or just above the upper limit and subsequently cooling at a fairly rapid rate is generally favorable, while annealing at or just above the lower limit is exceedingly injurious. The effect of passing the alloy through several such heat cycles is shown by the curves in the diagram in each case the specimen was kept at the temperature indicated during several hours and then allowed to cool in air If quenched from a temperature 50 deg to 100 deg above the upper limit the specimens were non magnetic

As noted the transformation temperature of the alloys appears to depend on the percentage of copper present

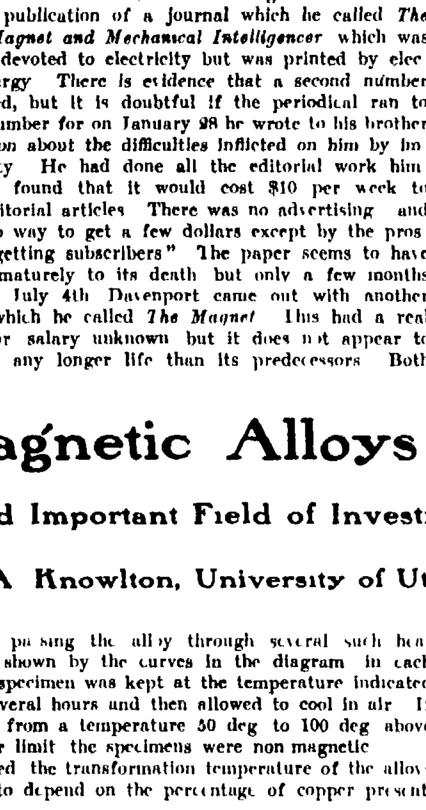


DIAGRAM SHOWING EXPLANATION OF CURVES ALL CURVES REFER TO THE SAME SAMPLE

20 6 per cent. Mn 8 2 per cent. Al 0 2 per cent Cu 0 2 per cent. Si Curve 1 best conditions after heating to 1 deg during thirteen hours 2 after eight hours near 200 deg and five hours between 275 deg and 300 deg (an other heating of five hours at 100 deg and two hours at 200 deg produced no further change) 3 five hours at 200 deg 225 deg 4 annealed at 225 deg after heating above transformation point 5 after nine and a half hours at 250 deg 6 after fourteen hours at 200 deg 350 deg

One specimen containing about 70 per cent of copper, can be picked up from a cake of ice by a small magnet but cannot be picked up from a table in a room at ordinary temperatures, as the upper limit of its transformation range is about 20 deg C. and its full magnetic quality is not attained above about 15 deg C below zero This specimen when tested at 0 deg shows a rather low magnetic permeability, becoming saturated at low values of the field; it exhibits almost no hysteresis loss, all of which phenomena are characteristic of all specimens near their upper transformation limit

Microscopic examination of a considerable number of specimens has shown that extensive changes in the crystalline structure always accompanies the changes in magnetic quality

No sample in which the bright crystals were lacking was at all magnetic under any conditions, while all specimens showing these crystals were magnetic at temperatures below the transformation temperature Apparently the magnetic quality depends upon some constituent of the bright crystals which may take on or lose its magnetic quality without the crystalline mass being destroyed the transformation involves very slight energy changes as careful observation has failed to afford any definite evidence of recalescence within the transformation range

The alloys in which aluminium is displaced by some other trivalent metal have been less studied but appear to behave in a way quite like the above Besides these, an alloy of a small amount of iron with larger amounts of nickel and chromium is strongly magnetic while curiously enough an alloy containing 25 per cent nickel and 75 per cent iron is non magnetic unless cooled to a temperature somewhat below 0 deg when it becomes magnetic and remains so until strongly heated, consequently a bar of nickel steel may be cut in two parts and after proper treatment under apparently the same conditions the one piece may be in the magnetic and the other in the non magnetic condition

Within the last few years alloys of iron with about 4 per cent of silicon have been found to be of great value for commercial use in building transformers as the hysteresis loss may be considerably less when the transformer core is made of such alloyed steel than when soft iron is used

From what has been said it is evident that the study of the magnetic properties of alloys is of great importance both because it seems likely to help us toward a better understanding of the nature of magnetism and because of the technical improvements which may result It should perhaps be stated that none of the alloys except those containing large amounts of iron are valuable in commercial work

In conclusion it is interesting to notice that Mr O C Clifford has found alloys of copper and tin more strongly diamagnetic than copper itself thus duplicating the phenomena of the Heusler alloys among diamagnetic materials—*Science Progress*

The Power Plant of Lesquinn

AN extensive steam and electric plant is erected at Lesquinn France where the Thomson Houston Company has shops for manufacturing Curtis steam turbines, in connection with the Paris central works All the machine tools are run by electric motors The boilers are needed for use in the electric plant as well as for testing the turbines and an extensive testing room is fitted out The boilers have a large output, 40 000 pounds of steam per hour and the super heaters give various temperatures of steam for testing purposes A forced draft is given by the use of properly combined motor-driven blast fans and smoke flues Four boilers are used built in two pairs and each pair is operated by a 30 horse power motor blower Anzin briquettes and also coal are used in the grates The condensing plant uses two condensers with the necessary pumps and scarcity of water required the use of an extensive water-cooling plant

New Methods in Astronomy*

Their Application to the Evolution of Our System

By F W Henkel, B A., F R A S

During the last few years the researches of eminent British and Continental astronomers have thrown a flood of light upon some of the most recondite problems of the science Among these may be especially mentioned the work of Dr Hill M Poincaré and Sir George Darwin, and we propose giving a simple account of some of their results as well as the bearing these have upon theories as to the origin of our system The Laplacian nebular hypothesis greatly shaken by later discoveries and the critical investigation of its postulates seems likely to undergo the fate prophesied for it by the late Mr Proctor founder of *Knowledge* and his words may be quoted here "If ever proper inquiry is made into Laplace's nebular hypothesis, that also will be still more decisively rejected" (*Old and New Astronomy* p 638) We shall have occasion to allude to some of the alternative hypotheses an account of part of Prof See's work has already appeared in *Knowledge*

Newton in his immortal Principia has once for all solved the problem of two bodies "Given two spherical masses acting on one another according to the law of gravitation and their position and motions at any time, to find their motions at any future or past time" The planets move in ellipses closely approximating to circles round the sun the comets mostly move in parabolas, a few in very elongated ellipses and perhaps a very few in hyperbolas round the same center of force This however is only an approximation though very close to their motion arising from the fact that the mass of the sun is so enormously great compared with that of any of the planets that the attraction between sun and planet is the main factor in determining the path of any one of these bodies Every planet moves in an orbit round the sun which is very nearly the same as it would be were no other bodies but itself and the sun to exist; the small deviations between the actual motion and this ideal motion are known as perturbations and are due to the disturbing action of the other members of the solar system arising from the difference of their attractions upon the sun and the planet in question in each case Owing to the fact that, as we have mentioned above all the planets are much smaller than the sun we may by a series of approximations determine these perturbations one after another and add their results till we obtain a satisfactory agreement between theory and observation The general problem of three bodies is however far beyond the capacity of our present mathematics to solve and all that can be done is to take some simple cases and then consider others approximating to them as nearly as possible

The moon moves in a path around the earth which is not very different from a circle but owing to the disturbing action of the sun the form of this path is continually undergoing slight variation In this case though the disturbing body is not small yet on account of its much greater distance the sun's disturbing force or its difference of action upon earth and moon is only a small fraction of the earth's attraction upon the moon Were the sun to attract earth and moon equally and along parallel directions there would be no disturbance of their relative motion In a similar way we may say that any

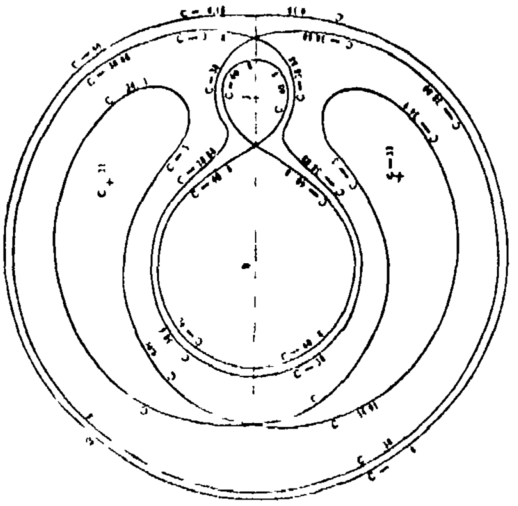


Fig 1 Curves of Zero Velocity (After Darwin) Critical Values Only Shown

external force acting equally upon all members of our system will produce no change in the planetary and satellite orbits Whatever force may be moving our sun along its mighty path toward "Hercules" (or Vega), is equally drawing its family of planets satellites, comets and meteors Even as it is however, with the comparative simplification introduced by the smallness of the disturbing force the "Lunar Theory" is one of the most complex branches of applied mathematics, and though the general agreement between the results of theory and observation affords one of the most complete verifications of the exact truth of Newton's law of gravitation there are questions even yet awaiting solution Dr Hill, in 1876, pointed out a new method of treating the problems of the lunar motion, and he took as the first approximation, not the ellipse, but what he called the variational curve as the moon's orbit. The moon is considered to move in a circle distorted by the sun's attraction, and this orbit is called a "periodic one," its period being one synodic month (i. e., interval from new moon to new moon or full moon to full moon, 29½ days) The eccentric form and the change of inclination (the moon's path is not in the plane of the earth's orbit but is inclined at an angle of about five degrees to it) are "free" oscillations about the periodic orbit, the "annual equation" (arising from the varying distance of the sun at different times of the year) is a "forced" oscillation M Poincaré, M Gyldén, and Dr Charlier have continued this

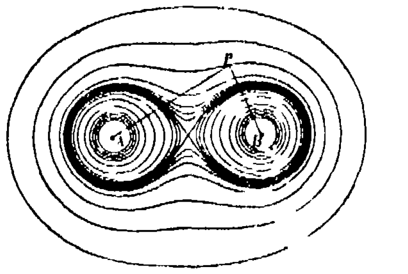
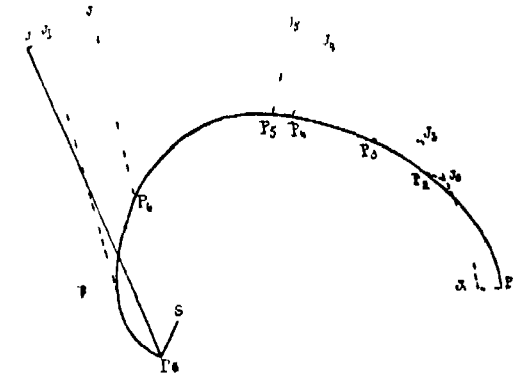


Fig 2 Equipotential Surfaces About a Double Star With Equal Components of Equal Mass (After Darwin)

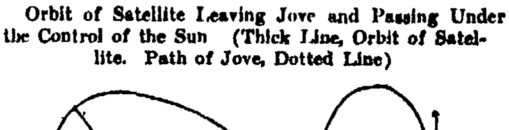
subject from the purely mathematical point of view, while Sir George Darwin has also dealt with it numerically in a comparatively simple manner, and we propose to give a brief account of some of his work He begins by considering the case of three bodies, called respectively the sun a planet moving around it which he calls Jove, and a third body whose mass is infinitesimal (so that it will produce no appreciable effect upon the motions of the other two) which he calls the planet, or satellite Jove (J), of unit mass, moves round the sun, of mass* ten in a circle, and all three bodies lie in one and the same plane He first obtains what is called the equation of relative energy (the well known Jacobian integral $V^2 = 2\,\Omega - C$) Since for real motion V^2 must be positive $2\,\Omega$ must be greater than or at least equal to C and so the planet can never cross the curve represented by $2\,\Omega = C$ which agrees with Dr Hill's result in assigning definite limits to the past and future position of the moon in our system He then considers the form of the curves obtained by giving different values to the constant C called the constant of relative energy For large values of C they are closed ovals around S and J respectively with an outer branch around both S and J The larger oval shrinking as C become less, unites with the inner oval around J and the curve becomes of horseshoe shape The horse shoe then narrows at the middle and breaks into two elongated portions, these gradually shrinking into two points equidistant from S and J Fig 1 shows the form of the curves for the critical values †

It was shown by Lagrange, more than a hundred years ago that there is an exact solution of the problem of three bodies when they are each at one angle of an equilateral triangle which revolves uniformly, and since two triangles of equal altitude may be drawn on the same base (one above and the other below SJ) there are two such positions This is approximately realised in our system A minor planet recently discovered revolves at about the distance of Jupiter from the sun, and this arrangement appears to be a stable one In addition to the above determinations, Sir George Darwin has also considered the case of a satellite leaving Jove and passing under the control of the sun, and Fig 3 shows the path for $C = 39$ referred both to axes fixed in space and to revolving axes. The full curve shows the path of the planet the dotted one is that of Jove, and lines are drawn joining the simultaneous positions of these bodies (In order not to complicate the figure only a few of these are drawn) The body here makes a single revolution around Jove and is then drawn off to the sun, but it may happen that several revolutions around the former would be made until conjunction takes place at "apojove" (greatest distance of planet and Jove), and then it will revert to the sun again "It seems likely that a body of this kind would in course of time find itself in every part of the space in which its motion is confined" (Darwin) Thus it would at last collide either with the sun or Jove, and it has been suggested by the same writer that in this way stray bodies are gradually swept up by sun and planets Some non periodic orbits passing from Jove to the sun are drawn in Fig 4, and it will be seen that one of these paths has a sharp cusp (lying on the curve of zero velocity) another is looped, and so on

Regions within which stable orbits are possible and others for which they cannot exist, are found, and in this connection we may later find an explanation of Bode's law as to the distances of the planet and satellites from their primaries. In his later work, Sir George Darwin has considered possible retrograde orbits, all his former researches having been on orbits where the motion is direct, i. e., the same direction as that of all the planets and most of the satellites, and has traced the forms of paths of bodies ejected from sun toward Jove and *vice versa*. Modes of transition between direct and retrograde orbits are also considered, passage through the apices of the equilateral triangle on SJ as base already mentioned being suggested as one method. From a consideration of the figures given we may gain much information as to the kind of orbits possible, and the limit of distance between planets and satellites. For values of C greater than 40 18 the third body must be either a superior planet moving outside the larger curve, or an inferior planet moving inside the larger internal oval, or a satellite inside the smaller oval, and it can never change from one of these forms to either of the others, "so that this limiting value gives superior limits to the radii vectores of inferior planets and of satellites which cannot sever their connection with their primaries." When C is less than 40 18, and greater than 38.88, the third body may be a superior planet, or an inferior planet, or satellite, or a body moving in an orbit partaking of the two latter characteristics, but it cannot exchange from the first *rôle* into either of the others When C is less than 38.88, and more than 34 91, the body may move anywhere except inside of the "horse-shoe" shaped space Here the distinction between planetary and satellite motion does not exist, and the body may change from any one of these modes into any other When C lies between 34 91 and 33, the only regions where motion is not possible are within the leaf-like folds on each side of the line SJ, and these diminish to the pair of points marked with crosses (Fig 1), for the value $C = 33$. Lastly, when C is less than 33 the body may move anywhere. As a general result it is concluded that unstable orbits are such as to lead to the ultimate absorption of bodies moving in them into one or other of the larger bodies, and though the problem in our planetary system is much more complicated from the large number of planetary bodies, yet, as we have seen, several interesting features have indicated explanations We have now to briefly notice the bearing of these results upon cosmogonic theory, and some modifications suggested by Prof See By supposing the existence of a resisting medium universally diffused throughout our system, of whose presence we have some evidence, we get the well-known result that when a body revolves about the sun or a planet, the resisting medium at every point decreases the velocity, and thus gives the central attraction more effect, the revolving body being gradually drawn nearer to the center of force For Encke's comet this change seems more rapid than for any other known member of our system. For orbits differing from circles the result of the action is also to diminish the eccentricity or make them more nearly circular This was well known to Laplace, and the proof is given in works on analytical dynamics. Thus a particle moving within one of the inner closed surfaces,



A Orbit of Satellite Leaving Jove and Passing Under the Control of the Sun (Thick Line, Orbit of Satellite. Path of Jove, Dotted Line)



B Referred to Moving Axes

Fig 3.—(After Darwin)

of which we may regard the curves (shown in Fig 1) to be the traces on the plane of paper, will gradually draw nearer its center, and, its speed increasing, its periodic time will be diminished; for a body moving within the "hour glass" shaped space or the pear-shaped region surrounding both bodies (Fig. 1) will drop nearer and nearer to one or other of the masses, and may finally pass within the closed surface and acquire a constant of relative energy such that it can never escape again from that region. The moon is now within such a closed surface about the earth, and cannot escape therefrom, and it has been accordingly supposed that it has not at any time been outside; but if we admit the action of the resisting medium there is a possibility of our moon's

* Reprinted from *Knowledge*.

*The value of ten for the mass of the Sun in terms of Jove is taken for the purpose of exaggerating all the phenomena of perturbation as compared with those in our system, so as to give a clearer view of their nature.

†We may regard these curves as the traces on the plane of the paper of surfaces of zero velocity By taking all three bodies in one plane the problem is reduced to a two dimensional one.

having been an independent planet which approached too nearly to the earth and became captured At present most astronomers give in their adhesion to Sir George Darwin's theory of tidal evolution, according to which our moon once formed part of the earth's substance. It is supposed that once upon a time the latter was rotating much more quickly than at present, and that a portion separated from the rest and became the moon. The time of the earth's rotation was estimated to be then about two and a half hours, so that the "centrifugal force" caused its rupture. The separated portion may have gradually receded to its present position by tidal action Difficulties as to the possibilities of the moon's holding together under tidal strain when so much closer to the earth than at present, and the cause of the supposed very rapid rotation of the earth in early ages, have been raised by various writers, so that we may at least regard the alternative capture theory and action of the resisting medium as a possible explanation, though it seems difficult to imagine that all the relations pointed out by Sir George Darwin are purely accidental. The Laplacian hypothesis, with the modifications suggested by Faye and others and supplemented by the theory of tidal evolution, has been nevertheless shown to be untenable, and the evolution of the planets by separation of rings of matter from the central condensation as it contracted must be definitely abandoned. Briefly stated the theory is as follows: The matter now forming sun, earth and other planets was at one time in the form of a hot gas and was of approximately spherical form. It rotated slowly on its axis, the rotation increasing in swiftness as it grew colder and contracted In time rings of matter were left behind Each of these rings gradually collected into a single globe, and thus the planets came into existence A planet thus formed continuing to revolve itself in turn abandoned rings in contracting and thus arose the satellites. This process is illustrated by a well-known experiment, devised by Plateau He formed a mixture of alcohol and water of the same density as oil (water being heavier, alcohol lighter) and poured into this mixture a quantity of oil The oil sank about halfway and floated in the middle of the mixture as a round ball. By means of a disk attached to a wire Plateau made it rotate The rotation caused the ball to spread out into the form of a spheroid; then, as the speed increased, a ring was thrown off which revolved around it The ring broke up after a time and collected into a smaller globe which rotated and also revolved around the larger, then another ring was thrown off as the speed again increased, and so on Babinet, however, in 1861 showed that the original nebula imagined by Laplace could not have rotated with sufficient speed to detach any of the planetary masses, and his argument has been extended by Prof See to show that, similarly the satellites could not have separated from their primaries. There has therefore been proposed an alternative fission theory that secondary condensation nuclei might be formed by gravitational instability within the gaseous nebula, as also the capture theory referred to above together with the "spiral" nebula form A spiral nebula is supposed to be formed from a sun by the near passage of another star the consequent ejection of matter forming two spiral arms bearing nuclei at irregular intervals The particles of these arms move around the central nucleus in elliptic orbits, the planets being formed by the gradual growth of these nuclei, by the addition of small "planetesimals Prof See considers that our solar system was formed from a spiral nebula and that the planets have not been detached from the central mass by rotation, but "captured," or added on, from the outer parts of the nebula their orbits have been "rounded off" by the resisting action of the medium in which they move and the particles moving in orbits confined to regions of the nature of those indicated in the researches of Darwin alluded to in the earlier part of the paper Moving against resistance they will all drop nearer to one or other centre of attraction some will become satellites of one planet some of another while yet others will collide with and be absorbed by these latter or fall upon the sun Thus the greater masses will increase, and in some such manner the "secular acceleration" of the sun and the unexplained acceleration of Mercury may be explained In our system we have a large central mass, the sun with attendant planets, but in some cases we may have a more nearly equal division of the matter, as in the double stars Fig 2 shows the equipotential surfaces about a double star with equal components (or rather their traces on the plane of the paper) In such cases the planets which are developed if they can continue revolving in stable orbits, will have to be near either one or other of the large masses, or else at great distances from both, if their motion is to be of a permanent character However, the existence of such bodies, though probable is not likely to be revealed by any increase in telescopic power of our present instruments. Great numbers of spiral nebulæ are now known to exist, scattered all over the heavens, while there are very few of the oblate spheroidal form, such as the hypothesis of Laplace assumed to be met with in the sky This was pointed out by Proctor and Ranyard (*Old and New Astronomy* § 1445) Such nebulæ as we see have a greater analogy with the solar corona than with the fiery condensing mist conceived of by Laplace The opposite branches often seen on photographs of spiral nebulæ are considered to represent the "original streams of cosmical dust coiling up and forming spiral systems." If the streams converge and the mass becomes very dense at the center, a double star may be formed.

The theory of the action of a resisting medium gives results exactly the opposite of tidal friction. The latter usually increases the major axis and eccentricity of a planetary orbit; the resisting medium decreases both these elements. "In the actual universe both causes are at work, sometimes one predominating, sometimes the other"

In the growth and development of our system all these various agencies may have been called into play, so true is it that here, as elsewhere, no single explanation is self comprehensive and exclusive of other hypotheses The mind of man is so constituted that it cannot help speculating on such topics, but it is well to remember that all our knowledge, both of time and space, is essentially relative and conditioned; no absolutely undisputed truth is admitted by all philosophers alike so that in some

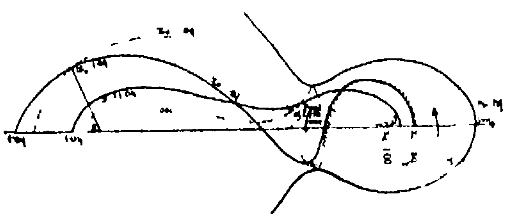


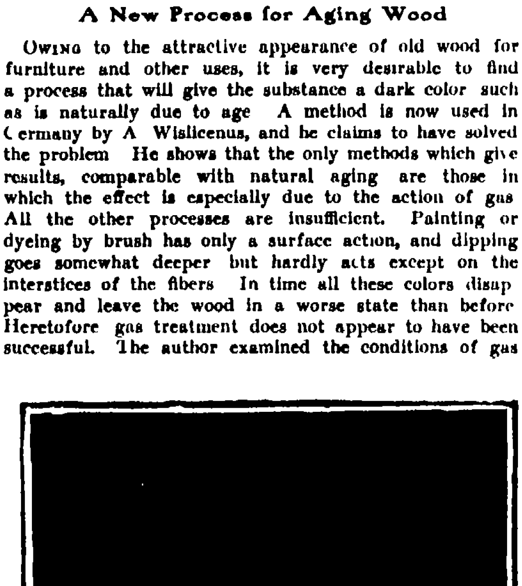
Fig 4—Non periodic Orbits Passing from Jove to the Sun (After Darwin) Outer Thick Line Curve of Velocity C = 39 0

respects we seem less advanced than was thought to be the case a century ago The sun was supposed to have an absolute velocity of about fifteen miles per second "toward a point in the constellation of Hercules, but as has been pointed out, this result has been overthrown by the work of Kapteyn Numerous optical and electrical experiments have been made at different times with the view of determining the absolute velocity of the earth, but such effects have always failed to appear

The vast masses of observational data accumulated by the persevering industry of self-denying men of science,' together with the mathematical researches we have outlined above, are leading to more accurate views than any that have been held hitherto and the results already obtained should give us encouragement in our efforts to trace the process of Creation but we must more than ever feel how little after all is yet known compared with what remains to be learned

A New Process for Aging Wood

OWING to the attractive appearance of old wood for furniture and other uses, it is very desirable to find a process that will give the substance a dark color such as is naturally due to age A method is now used in Germany by A Wislicenus, and he claims to have solved the problem He shows that the only methods which give results, comparable with natural aging are those in which the effect is especially due to the action of gas All the other processes are insufficient. Painting or dyeing by brush has only a surface action, and dipping goes somewhat deeper but hardly acts except on the interstices of the fibers In time all these colors disappear and leave the wood in a worse state than before Heretofore gas treatment does not appear to have been successful. The author examined the conditions of gas



The Spiral Nebula M 51 Canum Venaticorum (After See) Illustrating the Spiral Theory

action and finds that it is essentially the same as that which occurs in natural aging of wood, so that he may deduce an artificial process which gives about the same results as the natural one The new process is in use at an establishment at Dresden and it is rapid and certain, as well as cheap Wood tissue contains about 50 per cent cellulose, also lignine and imbedded mineral and organic matter, among which are tannins and iron salts. It is difficult to find which of these latter constituents is accountable for the brown color of old wood. We know that lignine becomes yellow and even brown by exposing it to air and light Book and journal paper owe their yellow color to it This paper is, in fact, a mixture of cellulose (often known as chemical paper paste), free from lignine and extracted from wood by what is known as the bisulphite process, and of soft wood paste still containing all the constituents of wood tissue and therefore the lignine On the other hand it appears that tannins and iron salts contained in the sap which are very sensitive to oxygen and light, also play a part, for woods having much tannin become brown more rapidly than others in general. However this may be, the finest natural coloration of wood is seen on Alpine chalets placed at very high altitude near the snow line where the air is pure and the light is rich in ultra violet rays The color may even reach a blackish brown for wood several centuries old But even in these conditions we observe old wood which is quite discolored and becomes a snow white This is produced near stables etc, and it is due to ammonical vapors added to other agents, such as water vapor oxygen and ultra violet rays Analysis shows that such wood is entirely composed of cellulose and the lignine and all imbedded matter is eliminated or destroyed by the combined action. In the case of browning, as well as of bleaching the action is a deep one. Combining the effect of these four agents in different proportions it was possible to obtain tints varying from gray to browns The old empirical methods for artificial aging were based upon this Wood was buried in trenches under a mixture of muc and more or less complex manures giving rise to a fermentation and thus ammonia was slowly given off However the brown color was due more to impregnation of colored liquids and a commencement of rotting, and the darkest color rather resembled water soaked wood than that which is exposed to the air of the mountains.

In the new process, the wood is placed horizontally in 2 foot ditches having a porous bottom and covered with a mixture of earth containing some humus but which should not be clay or sand exclusively A grain of 3-7 millimeter (0 12-0 28 inch) size should be obtained by sifting so as to be very regular Should such earth not be had common ashes can be used instead as these have always enough carbon for the purpose The ashes are crushed and sifted Such material is always permeable to water and air and does not hold back any great amount of liquid when the trench is watered or rained upon Alternate watering and draining set up a great circulation of air which gives an oxydizing action The slow oxydizing of the combustible materials of this layer no doubt gives rise to hydroxyl which has a strong effect on the wood Such an effect is increased or completed by the addition of substances which give off ammonia slowly Numerous tests show that the best results are obtained by adding 2 per cent of a mixture of ammonia salt and quicklime to the earth We mix them by a spade upon a plank floor using earth as dry as possible so as to avoid loss of ammonia For the same reason quicklime is to be employed For the best effect however, we use powdered chalk and sal ammoniac such as is sold for fertilizer Under the action of moisture a small amount of sulphate of ammonia which is dissolved out, comes in contact with the carbonate of lime There is formed sulphate of lime and carbonate of ammonia, and the latter is easily decomposed to carbon dioxide gas and ammonia so that the latter gas is given off slowly and regularly thus being more efficacious than if we used quicklime Better results are had by giving a good drainage and covering over with fine sand or cloth sacks so as to keep in the ammonia Thus treated the wood becomes colored in the whole of its mass, and the process can be used for any kind of wood But some woods give better results than others Oak is one of the best and is rapidly colored to a fine brown This goes down very deep below the surface of the wood Ash and beech wood can also be used very well Resinous wood such as pine is not so good However the process can be applied to redwood cypress and pitchpine

A Sliding Gate Dam

THE new 30 000 horse power Tuilere hydraulic plant in France is remarkable from the fact that it uses a slide gate barrage and there are but few examples of this construction for large plants in Europe Another lies on the Rhone near Geneva The Tuilere station ranks among the large European plants of to-day As to the barrage, it is composed of eight spans containing the same number of metallic gates Piers are built at a height of 165 feet above the water stage and between these the gates work in a slide Over the tops of the piers is a continuous metallic flooring structure and it carries the electric motor driven winches which raise and lower the gates by chain and counterweight The fore ends of the piers which contain the grooved sliding way are of reinforced concrete strengthened by vertical I beams which go down in the foundation bed The width of the gates is 36 feet and the height is 44 feet In this plant the turbine house lies alongside the dam so that the water comes almost direct to the turbine chambers A head of water of 20 to 40 feet is here used Before each turbine chamber is a gate 23 feet wide by 15 feet high, operated by hydraulic pressure from a hand lever device Turbines of the Francis type, nine in number are used working at 107 r p m., and giving each 3,000 horse power maximum On the turbine shafts in the room above the main alternators are mounted The hyrdaulic work includes a by pass around the turbines, to take off part of the water when necessary, and thus to regulate the level without operating the main gates An extensive steam plant using Thomson-Houston Curtis turbines is used as a standby The present station supplies current for Bordeaux and other places.

The Determination of Standard Time*

How the Astronomer Sets Your Watch for You

By C H Gingrich

ALTHOUGH Astronomy from the earliest time to the present has had a host of ardent and enthusiastic students and although scarcely a person can now be found who is not profoundly impressed and deeply interested in the transcendent beauty of the sky if his attention be called to it especially so if he have an opportunity to examine through a telescope the numerous objects in the sky that are invisible to the naked eye yet very few know anything very definite about the nature and methods of work at an observatory It is almost universally true of visitors who come to our observatory that the thing in which they seem to feel the keenest interest is the method by which accurate time is obtained This indeed is quite the natural thing for every one many times each day has occasion to think of time and this then is the point of closest contact that most persons have with the science of Astronomy

Since day and night are of necessity determined by the rising and setting Sun, the opinion is very general among persons who have not inquired into the subject, that time is taken directly from observations made of the Sun We have some time heard the phrase honest as the Sun the value of which as a figure of speech is greatly diminished when the exact movements of the Sun are understood Of course the movements of the Sun extending through the period of a year are very definite, and of the utmost precision, but they are quite variable from day to day It is not then from the Sun, but from the distant and so called fixed stars that time is taken This at first thought would seem to introduce more uncertainty than ever for the most casual person will observe that the sky is not the same at all seasons of the year The constellations that appear at night in winter for example are not the ones that appear in summer and the positions of a star in the sky at the same hour in two successive nights are not the same It need scarcely be said that the constellations such as Orion, that are so brilliant during the winter months in this latitude pass overhead during the summer months in the day time and are consequently rendered invisible by the brightness of the Sun

In order to reconcile this apparent variability with the very exact and accurate nature of the time that railroads and numerous other enterprises require for their successful operation it is necessary to call attention to the fact that there are four kinds of time whose characteristics and interrelations should be clearly understood They are Sidereal Time True Solar Time Mean Solar Time and Standard Time

Sidereal time as its name suggests is star time If at a certain instant a given star is on the meridian then after twenty four Sidereal hours have elapsed the same star will again be on the meridian Since the distant stars keep the same positions in space because their tremendous distances from us render any change imperceptible in long period the regularity with which a given star comes to the meridian is dependent only upon the uniform rotation of the Earth on its axis

Although there are forces operating to change the time of rotation they are so small and opposite in effect that they are negligible The meteors that strike the Earth and the tides are two forces that tend to retard the rotation and lengthen the period and on the other hand we have the contraction of the Earth and the constant erosion of soil from higher to lower altitudes, forces that tend to accelerate the rotation and shorten the period By taking all such forces into consideration it is definitely known that their resultant could not change the period of rotation by as much as one second in ten thousand years In the great complexity of changes that are going on about us we have the period of rotation of the Earth on its axis as an unvarying quantity and it must serve us as our starting point in the exact determination of time

The Sidereal day then is the time that elapses between two successive passages of a star across the meridian and is divided into twenty four hours Likewise the true solar day is the time that elapses between two successive passages of the Sun across the meridian The true solar day is longer than the sidereal day because of the fact that the Sun has a motion toward the east that stars do not have This motion is due to the Earths revolution about the Sun in one year The relative motion of the Earth to the Sun will be the same for our purpose if we consider the Earth as fixed and the Sun as moving about the Earth If we suppose then that the Sun and a given star arrive at the meridian at a certain instant, we know that after twenty four sidereal hours the star will again be on the meridian, but in the meantime the Sun will have moved eastward and some minutes more must pass before the Sun arrives at the meridian An idea of the quantity of this motion of the Sun toward the east may be formed from the fact that a complete circuit of the sky is made by the Sun in a year This motion however is not uniform, because the Sun moves not in a circle about the Earth as a center but in an ellipse having the Earth at one of the foci The angular motion then is variable and the True Solar day, though always longer than the Sidereal, varies from 3 minutes 35 seconds in Sidereal time longer in September to 4 minutes 26 seconds longer on December 22nd We ordinarily think of December 22nd as the *shortest* day, when in another sense it is really the *longest* day in the year Because of this irregularity in the length of the True Solar day it would be very difficult, if not entirely impossible to construct a clock that would constantly show True Solar time

This leads then to the introduction of Mean Solar time. We suppose a Sun that starts with the real Sun, and travels in the plane of the equator toward the east a uniformly equal distance each day and just rapidly enough to complete the circuit in the same time as the real Sun does so that the imaginary or fictitious Sun arrives at the starting point at precisely the same time as the real Sun This imaginary Sun at certain seasons comes to the meridian in advance of the real Sun and at other seasons after it. Since its angular motion is uniform, the time between two successive transits of the imaginary Sun across the meridian will always be the same This Mean Solar day is 24 hours 3 minutes 56.556 seconds long in Sidereal time This period is divided into twenty four solar hours, and this is the hour that is indicated on the dial of the ordinary clock The further modification of Mean Solar time to obtain Standard time is for convenience only and not caused by any necessity in the time itself, nor in the difficulty of constructing clock, for Mean Solar time is uniform just as is Standard time A moment's thought will show that if time as shown by clocks were the Mean Solar time then all places on the same meridian would have the same time, but a place a few miles east or west of a given place would have different time This time is sometimes kept and is called local time, but endless confusion in travel would result if railroads were operated by local time. Hence in certain belts the time is fixed by the time of a meridian near the middle of the time belt These belts are 15 degrees wide, so that in passing from one belt into another the time changes abruptly by one hour These belts, moreover, are arranged so that time in them is an integral number of hours from Greenwich. By this arrangement the error in time at any particular place will not exceed one half hour

Standard time then is the kind that is ultimately sought Obviously there is no object in the sky that can be observed for Standard time directly Nor, indeed can Mean Solar time be determined by direct observations, for the Sun which determines it is purely fictitious However, the real Sun may be observed directly, and then since the relative positions of the real and the fictitious Sun can be computed for each day, and indeed, are tabulated in the *American Ephemeris* and also in other almanacs in the form of equation of time. True Solar time, as observed, may be changed into Mean Solar time, and this in turn may easily be converted into Standard time, provided the longitude of the place at which the observation was made is known Various methods of observing the Sun may be used, one of which is by use of the sextant, which cannot be made very accurately, and another is to use a permanently mounted transit instrument, and to observe the moment when the Sun is on the meridian The difficulty here lies in the fact that the Sun is so large that it is difficult to decide the exact moment when the center of the Sun is on the meridian Because of these practical difficulties the method of observing the Sun is not very often followed The method usually followed, and the one used at Goodsell Observatory, is by observing the star and it is the method which we use here that I desire to describe.

To determine time is really to determine the clock error It is not essential for that purpose that the error be large or small, though as a matter of fact the error is usually less than one minute. For if it were greater than that, it would be an easy matter, after a single determination of the error to move the hands until the error was made less than one minute

In order to determine the clock error two instruments are essential, first the transit instrument, and second the chronograph. The clock is provided with an escapement which breaks an electric circuit every two seconds. This circuit connects the clock with the chronograph which has as its essential part a cylinder which rotates once each minute About this cylinder is fastened a sheet of blank paper upon which a pen traces a continuous line as the cylinder rotates. The armature that carries the pen is released when the clock breaks the circuit, so that there is a series of offsets in the line that the pen traces, separated by exactly two seconds The escapement wheel is so arranged that the circuit is broken also at the fifty ninth second, so that one can tell by the record where the minute ended The minute during which the record was started is marked on the sheet, so that, by counting the minutes from that time one can determine any particular minute and second during the time through which the record extends

The transit instrument is mounted so that it is free to move only in one plane, namely in the plane of the meridian The reticle of the transit contains a number of wires which are illuminated, and which are located symmetrically with respect to the center If the wires are not exactly symmetrical with respect to the center, the error of instrument in this particular is found by trials and a correction is introduced into the reduction to account for that error The observer at the transit holds in his hand an electric button which, when pressed, breaks the circuit, and releases the armature, which carries the pen, in the same way as an escapement wheel in the clock does, so that he may insert offsets in the line traced by the pen in addition to those inserted by the clock regularly at the end of each two seconds. The transit instrument is also supplied with a graduated circle which serves as an indicator for setting the instrument at the proper altitude for the star to be observed.

With this equipment one is ready to proceed with the actual observation. Assuming that the error of the clock is small, he can tell from the clock what particular stars are near the meridian and will transit the meridian during the next half hour, more or less, during which his observations are to extend. If he had no indication at all as to the error of the clock, he would be obliged to observe some bright known stars and from these by perhaps rather rough approximation reduce the error until it becomes less than one minute Where such observations are made periodically the clock error is kept small. Then he knows what stars are about to transit the meridian, since the Sidereal time indicates the right ascension of the zenith at any time, and it is necessary only for him to look into any star catalogue and select such stars as have right ascensions a few minutes greater than the Sidereal time. From the same catalogues he can get the declinations, and knowing the latitude of the place from which he is observing, the altitude in which the star will cross the meridian may easily be determined Again at places where such observations are made regularly, a list of time stars is prepared and kept permanently This list shows the right ascensions of the star which is, indeed, the Sidereal hour when the star will be on the meridian, the declinations zenith distance, circles, setting for the instrument to be used, and usually the magnitude, so that the observer may have the brightness as a check on his selection of the star, for it is quite possible that more than one star may appear in the field of the transit. This list of stars is so chosen that in the course of an hour or less one can always find stars in the northern sky as well as near the zenith, near the equator and in the southern sky The reasons for such a selection will become apparent when we come to speak of the reductions of the observations.

When everything is in readiness, the observer selects a star that will cross the meridian in two or three minutes sets the instrument according to the position defined for this star in the star list, and takes his position at the instrument, having the electrical push button in his hand He may move the eye-piece to one side and thus get the star in view some time before it crosses the wires, but in any case the star swings into view, moving quite rapidly or very slowly, according as the star is near the equator or near the pole He selects the middle wire and a certain number on each side of it as those with respect to which he desires to record the transits As the star transits them he pushes the button and interpolates his record on the chronograph sheet upon which the clock is making its continuous record He then selects another star and records its transits in the same way Usually four or five stars are observed and recorded in this way, care being taken that the stars chosen shall not all be in the same region of the sky These then constitute a time set.

After this comes the reduction of the observations By reading the records for each star from the chronograph sheet by means of a scale designed for that purpose, and taking the mean, the clock time of the transit of the star across the meridian is found to the tenth or even to the hundredth part of a second The right ascension of the star, as given in the *American Ephemeris* at intervals of ten days throughout the year, is the actual time at which the star crossed the meridian If there is any discrepancy between the actual time and the clock time, this discrepancy may arise from several sources. If the transit instrument were in perfect adjustment the discrepancy would be entirely due to the clock error, but this is very seldom the case. However, there is no uncertainty on this point since the corrections to the instrument are carefully determined from time to time. Four quantities are recognized as contributing to the discrepancy between the actual time of transit and the clock time as shown by the chronograph record; first and most important, the clock error itself, second, the azimuth error, third, the level error, fourth, the collimation error The first is the quantity that is sought ultimately and is taken to be the discrepancy that remains after the effect of the other three has been removed. The second is obtained from the observations themselves and results from the fact that the rotation axis of the transit is not exactly east and west. If one imagines this to be exaggerated much beyond any possibility in any well mounted instrument he will easily see the effect. For instance, suppose the support for the east end of the rotation axis to be one foot north of the support for the west end, then it is easily seen that, when the instrument is directed toward the south, it will point considerably east of south, while

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if directed toward the north it will point west of north. This error may be very small, but must be considered. The third, or level error, is determined by the hanging level at each observation. This is due to the fact that one end of the axis may be higher than the other, which condition would also tilt the instrument out of the plane of the meridian. This varies slightly and must be determined each time. The fourth, a collimation error, is due to the fact that the mean of the eleven wires may not be exactly in the collimation plane, the plane which is described by the line, called the collimation axis, from the optical center of the object glass perpendicular to the rotation axis, as the telescope is rotated. Since the parts that affect this error remain relatively unchanged for long periods of time, it is necessary to determine this error once in two or three months.

These quantities are connected in the following relation:

$\Delta\theta + Aa + Bb + Cc =$ actual time — clock time of star transit, where $\Delta\theta$ is the clock correction, A, B and C are known quantities depending upon ϕ, the latitude of the observer, and δ the declination of the star, and are computed beforehand, and a, b and c are respectively the factors introduced by the azimuth, level and collimation constants. We have seen that c remains unchanged for long periods and hence is a known quantity. We have also seen that b is determined at each observation by the hanging level and consequently is known for each set of time stars. We have then four or five equations, depending upon the number of stars observed, of the form given above in which $\Delta\theta$ and a remain as yet undetermined. We select the two that are most diverse, which will usually be the most northern and most southern stars, since they will be oppositely affected by the azimuth error, and subtract the one from the other, thereby eliminating the $\Delta\theta$, and obtaining an equation from which a may be found. Applying this value of a to the four equations we get from each one a value of $\Delta\theta$. These separate values serve as a check upon the accuracy of the work and should agree very closely. Their mean is then taken as the value of $\Delta\theta$, the clock correction. Sometimes an additional correction, namely, the personal equation of the observer, is added, and when extreme accuracy is desired a greater number of stars is observed and the reductions are made by the method of least squares. However, the method outlined here gives results that may be depended upon to the tenth of a second. It might be said that the clock is not set each time that its error is found, for obviously the clock is quite as serviceable if the error is known as if it should show exactly accurate time.

This then gives accurate Sidereal time, and it remains now to show how this is converted into the Standard time which is the time we use. Since the Sidereal minutes are shorter than the Standard time minutes, the seconds do not beat together on the two clocks, but at intervals of approximately six minutes they do beat together momentarily and then the Sidereal clock beat precedes the Standard clock beat again. By noting the second on each clock when this coincident beating occurs we get a clock comparison. Now the Sidereal time shows the time since *Sidereal* noon, and this interval may be converted into an equivalent Standard time interval by tables that are constant. Also we find tabulated in the *American Ephemeris* the mean time of Sidereal noon for each day of the year. If then we add to the mean time of Sidereal noon on the day in question the interval of time that has elapsed since Sidereal noon we have the correct mean time for the instant at which the comparison was made. This is changed into Standard time by adding or subtracting the distance of the place in longitude expressed in hours from the meridian which fixes the time in the belt. This must be added for places west of the Standard meridian and subtracted for those east. The difference between this time and the reading of the clock at the time of the comparison indicates the correction to the Standard clock.

The correction cannot be effected by hand, since it frequently is only a few tenths of a second. The correction is made by a temporary magnet over which swings a permanent magnet, which is fastened to the pendulum. The temporary magnet is polarized by a current of electricity which may be sent in either direction and thus make the pole nearest the permanent magnet positive or negative as desired, and thereby accelerate or diminish the rate of the pendulum during the time when the temporary magnet is operating. The effect is sufficient to change the clock by about one hundredth of a second per minute, so that very minute changes may be made. This clock then may be used for sending time signals, as its error is reduced to zero.

Precautions in the Use of Explosives

IN a circular published by the Bureau of Mines and written by Clarence Hall some excellent precautions are given for the use of explosives, notably so-called permissible explosives, which are used in coal mines. Permissible explosives, it may be said by way of explanation, give a short and relatively cool flame, are less likely to ignite inflammable gas or coal dust than is the longer and hotter flame of dynamite, or the longer and much more lasting flame of black powder, and are intended for use in those coal mines where the presence of such gas or dust may render a mine explosion possible.

According to the circular mentioned the following precautions should be taken to reduce the risk in storing, thawing, handling and using explosives in coal mines:

(*a*) PRECAUTIONS TO BE TAKEN IN THE STORAGE OF EXPLOSIVES

Don't store detonators with explosives. Detonators should be kept by themselves.

Don't open packages of explosives in a magazine.

Don't open packages of explosives with a nail puller, pick, or chisel. Packages should be opened with a hard wood wedge and mallet outside of the magazine and at a distance from it.

Don't store explosives in a hot or damp place. All explosives spoil rapidly if so stored.

Don't store explosives containing nitroglycerin so that the cartridges stand on end. The nitroglycerin is more likely to leak from the cartridges when they stand on end than it is when they lie on their sides.

Don't repair a magazine until all explosives are removed from it.

(*b*) PRECAUTIONS TO BE TAKEN IN THAWING EXPLOSIVES

Don't use permissible explosives or other explosives that are frozen or partly frozen. The charge may not explode completely and serious accidents may result. If the explosion is not complete the full strength of the charge is not exerted and larger quantities of harmful gases are given off.

Don't thaw frozen explosives before an open fire, nor in a stove, nor over a lamp, nor near a boiler, nor near steam pipes, nor by placing cartridges in hot water. Use thawers, such as are furnished by the manufacturers of explosives.

Don't put hot water or steam pipes in a magazine for thawing purposes. Where large quantities of explosives are used a special thaw house should be built large enough to hold the quantity of explosives needed for a day's work.

(*c*) PRECAUTIONS TO BE TAKEN IN HANDLING DETONATORS AND EXPLOSIVES

Don't carry detonators and explosives in the same package. Detonators are extremely sensitive to heat, friction, or blows of any kind.

Don't handle detonators or explosives near an open flame.

Don't expose detonators or explosives to direct sunlight for any length of time. Such exposure may increase the danger in their use.

Don't open a package of explosive until ready to use the explosive, then use it promptly. All explosives are injured by exposure to the action of the air.

Don't handle explosives carelessly. They are all sensitive to blows, friction and fire.

(*d*) PRECAUTIONS TO BE TAKEN IN USING DETONATORS AND EXPLOSIVES

Don't use more than $1\frac{1}{2}$ pounds of any permissible explosive for one shot in a coal mine. No explosive is safe if used in large quantities under ordinary coal mine conditions.

Don't use a detonator (blasting cap) or electric detonator of less strength than that prescribed by this bureau. The explosive may not explode completely, thus reducing the work done by the shot and causing the same dangers that come from the use of frozen explosives.

Don't crimp a detonator (blasting cap) around a fuse with the teeth. Use a cap crimper, which is supplied by any manufacturer of explosives.

Don't economize by using a short length of fuse. Such practice is liable to result in a shot going off too soon.

Don't fire a charge of any explosive in the presence of fire damp. A fissure or crack in the coal or rock may bring the gas and air mixture directly to the explosive. Such fissures are most likely to be found in driving or breaking through. If gas is found when such a fissure is cut, clean the gas out before shooting. If the gas can not be cleaned out, cut through with the pick and fire no shots.

Don't use in a gaseous coal mine any fuse or other device which emits flame or sparks. The end or side spitting of a fuse or squib may ignite gas. Electric detonators give better results and are safer.

Don't tamp the explosive with coal cuttings or slack or any combustible material. Use damp clay, which is safer and better, and have this stemming fill the drill hole to its mouth.

Don't use a metal tamping rod. Even a copper tipped rod is not to be recommended. Use only wooden rods.

Don't use two kinds of explosives in the same drill hole. When such a charge is fired chemical changes may take place that may make each explosive less safe than if used alone.

Don't return to the face until at least five minutes after a shot has been fired. All explosives tested to date, including black blasting powder, yield inflammable and poisonous gases. Field tests made by this bureau in bituminous-coal mines indicate that some of the coal in the drill hole helps to form such a gas, and that a shot liberates inflammable gases from the coal itself. The liberated gases escape slowly from the cracks made in the coal sometimes for several minutes, but finally all the gases resulting from the shot diffuse in the mine air, and with proper ventilation are carried away.

Don't return to the face for at least one-half hour after a misfire. Hangfires and misfires are most likely to happen when squibs or fuse are used.

Don't attempt to draw nor to dig out the charge in case of a misfire. Some authorities believe that the great disaster at Courrières, France, in which 1,100 men lost their lives, was caused by a miner striking with his pick a cartridge he was digging out. Drill and charge another hole at least 2 feet away from the hole that misfired. After the coal has been brought down look carefully for any unexploded material.

Don't leave any detonators or explosives in a mine over night. The mine air usually contains moisture and is bad for all explosives.

Don't charge or load any hole which has not been properly placed or has been drilled on the solid.

Don't light the fuse of dependent shots at the same time the first shot is lighted. The inflammable gases from the first shot and the gases liberated from the coal itself, together with the coal dust in the air, may ignite from the spitting of the fuse of the dependent shots. The place for a following shot and the size of the charge to be used can be judged better after the first shot has been fired.

Don't expect to get satisfactory results with a permissible explosive or any explosive when a miner uses it for the first time. The most coal will be won for each pound of explosive used and the safety will be greatest if all shots are loaded and fired by men especially trained for this work. The practice of firing all shots by electricity after the men have left the mine is growing in favor.

Don't think the use of permissible explosives can take the place of other safety precautions in mines and thus neglect these other precautions.

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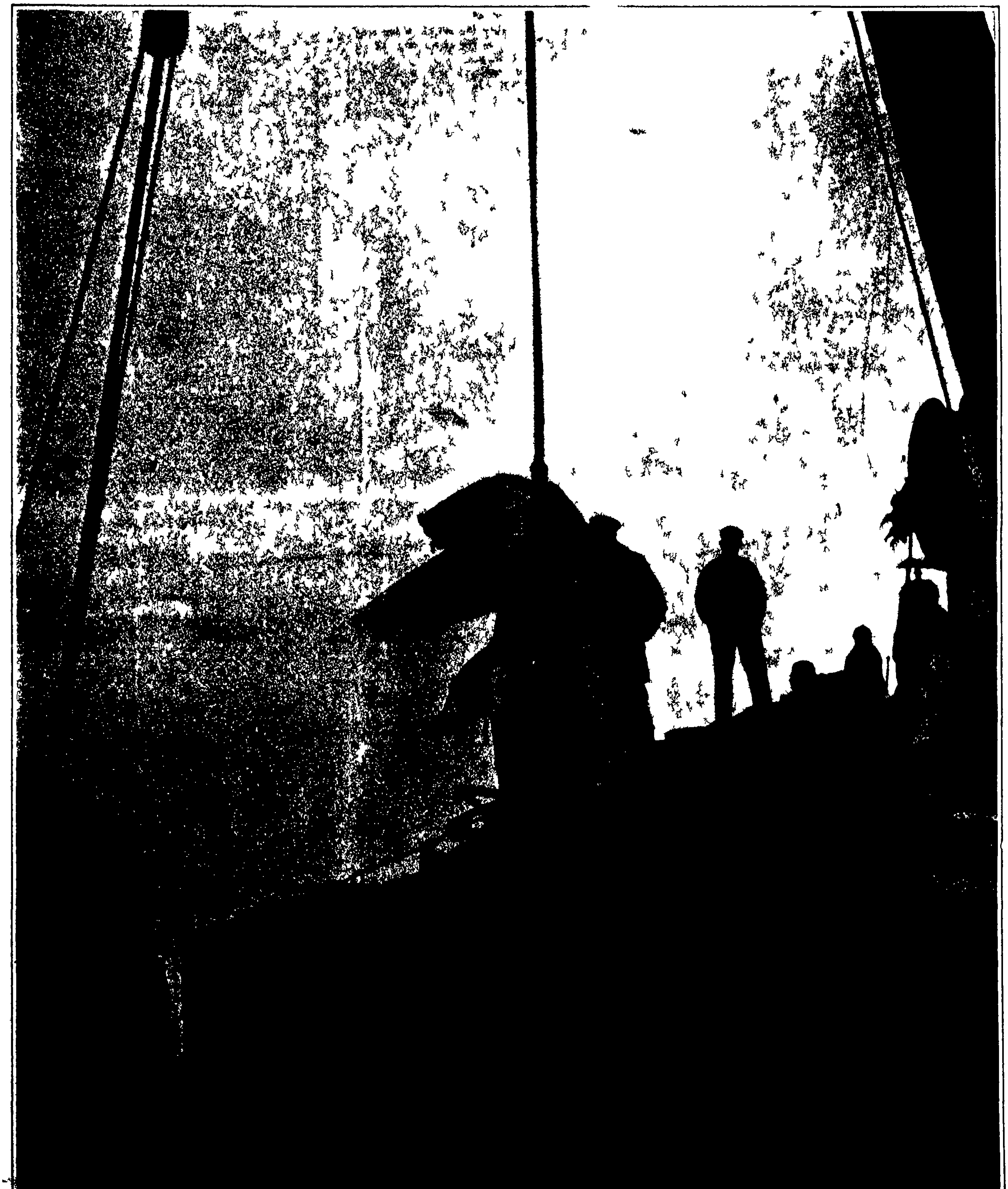

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SWINGING A GREAT POLAR BEAR OVER THE SHIP'S SIDE ON TO THE DECK

THE CAPTURE OF "SILVER KING"—[See page 169]

Stellar Magnitudes*

The Problem of Measuring the Brightness of a Star

By J E Maybee

It is an oddity of terminology and a survival of immemorial custom that a term expressive of size is used to designate the brilliancy of a star *Metaphorical language* seem almost out of place in an exact science like astronomy yet to the ordinary dabbler in astronomy the term magnitude used to express light giving power does not appear unapt for we are well accustomed to speak of a man of brilliant intellectual or moral acquirements as a big man and to the non scientific undoubtedly the biggest and most important point about a star is its relative brilliancy of appearance So we shall accept the term magnitude as expressing the luminosity of a star as viewed from our earth

The term is as already suggested an old one and comes to us from Ptolemy (140 A D) In the Ptolemaic cosmogony as is well known the stars were supposed to be set in a crystalline sphere and were all at the same distance from the earth It was not an unnatural assumption then that differences in brightness indicated difference in size The final triumph of the Copernican theory of the universe resulted in the passing away forever of *this* theory of stellar magnitudes but another quite as erroneous took its place namely the assumption that all stars are of the same intrinsic brilliancy and that the *difference in their appearance* is due simply to differences in their distances from us We now know that some of the most brilliant of the stars are comparatively distant and that others relatively dim are among our nearest neighbors We also know that there are dark stars Algol's dark companion for example and it is reasonable to assume therefore that stars vary not only in their distances from us but in their intrinsic luster as well

Stellar photometry is the branch of astronomical science which undertakes the task of determining the relative apparent brightness of the stars and any variations therein

It is an important branch of astronomical work for when combined with determinations of parallax and spectroscopic analysis it enables us to get an approximate *idea of the real sizes of stars* For it is evident that given a star which differs from another in brightness its distance and the *quality* of the light being the same the difference of brightness gives at once a measure of the relative sizes of the two Or if the brightness and quality of light are the same but the distances different the two stars vary in size directly as the square of the distance

Working along such lines it is found for example that though 61 Cygni magnitude 5 4 distance 6 5 light years, is only one seventh the solar mass Arcturus magnitude 0 24, distance 127 to 160 light years is possibly equal to a million suns

Having arrived at an idea of the meaning of "magnitude" as applied to stars, and of the importance of stellar photometry we shall now consider on what lines *stellar magnitudes are determined* Our present system of expressing magnitudes possesses several incongruities In the first place the smaller the magnitude the brighter the star There would be no great trouble about this however were it not for the fact that some stars are brighter than first magnitude Hence we have the anomaly of stars of 0 magnitude and even magnitudes Some further confusion is due to the fact that the eye does not perceive the actual ratio of brightness between two stars For instance, a star of the 3 5 magnitude might be supposed to be a mean between a star of the sixth magnitude and a star of the first magnitude. But not so a star of 3 5 magnitude is 12 6 times as bright as a star of the sixth magnitude And a star of the first magnitude is 100 times as bright as a star of the sixth magnitude and therefore 8 times brighter than a 3 5 magnitude star

Following this out it appears that if the brightness of a sixth magnitude star be called 1 that the brightness of a fifth magnitude star is 2 512 of a fourth magnitude star 6 3, of a third 15 8, say 16 of a second magnitude star almost 40 and of the first just 100 Magnitude 0 0 is represented by 251 2 and magnitude —1 by 631 In each case the brightness relative to the sixth magnitude star is found by raising 2 512 to a power represented by the difference in the magnitudes It follows then that to determine how many times one star is brighter than another you subtract the lesser magnitude from the greater and raise 2 512 (the light ratio) to a power represented by this difference This is easy when dealing with whole magnitudes but rather more difficult when stars differ by fractions of a magnitude But logarithms help us out of the difficulty The logarithm of 2 512 is 0 4 and we may raise 2 512 to any desired power by multiplying 0 4 by the index of the desired power which gives us the logarithm of the desired power and a reference to a table of logarithms will give the number corresponding to the logarithm so found which represents the number of times the lower magnitude star is brighter than the higher magnitude star Let us take a case Regulus is of a magnitude represented by 1 34, Sirius is of a magnitude represented by —1 58 (Miss Clerke) Subtract —1 58 from 1,34 and we get 2 92 Multiply 2 92 × 0 4, the logarithm of 2 512 the light ratio, and we have 1 168, and this is the logarithm of 14 72 so that Sirius is 14.72 times as bright as Regulus It should be clear then that the actual difference in brightness between two stars is much greater than it appears to the naked eye, for the eye is *not impressed in proportion to the actual difference*, but only in proportion to the logarithm of that difference, or, to put it differently stars which to the eye appear to form an arithmetical progression in brightness, in reality form a geometrical progression This will explain why a photographic tyro is so often deceived in the photographic value of the evening light His eye may tell him that the light is approximately midway between two known standards, and therefore he may decide on an exposure say of double that he would give under the brighter standard, while in reality the actinic value may be so much lower that eight times the exposure is necessary to proportionately affect the plate

The problem of stellar photometry is not an easy one as there are so many difficulties in the way of getting uniform conditions for observing For instance in the country stars look much brighter than they do in the city and on a mountain brighter than they do in the level country W H Pickering also thinks the seeing is much better nearer the equator than in the temperate zones Stars near the zenith also appear brighter than when near the horizon, and as some stars to an observer in a given station never rise far above the horizon his observations will give a lower value to the brightness of such stars than if they were observed near the zenith Thus observations of star magnitudes must have a correction applied reducing them to standard distance above the horizon if they are not observed under similar conditions Further eyes differ in their sensitiveness to light and thus one observer may get results different from those of another

The color of a star also may affect the results as some eyes are more senstive to one color than another Another curious thing is that if we take a green light and a red light of equal intensity and either double or halve the intensity they will no longer appear equal to the eye When the intensity of both is doubled the red will appear the brighter and when halved the green will appear the brighter It is also to be remembered that the atmospheric absorption for the different parts of the spectrum is not the same When all these things are considered it is no wonder that the photometric determinations of different observers vary

It will be interesting I think to consider the number of the stars of different magnitudes Here again doctors differ but I have used the figures given by Todd (1897) I = 20 II = 65 III = 220, IV = 500, V = 1 400 VI — 5 000 total 7,205 The number increases up to the tenth magnitude by a sort of rough geometrical progression the stars of a given magnitude being from 3 to 3 75 times more numerous than those of the next higher (i e brighter), so that there are about 720,000 stars of the tenth magnitude After that the ratio decreases so that it is probable that in the first 16 or 17 magnitudes there are not more than about 100 000 000 stars

A study of the total light giving power of stars of the different magnitudes reveals some unexpected results It will be remembered that the brightness of stars of different magnitudes increases in a geometric progression 2 512 being the ratio but the number of the stars of the different magnitudes from the first downward to 10 increases as above stated in a geometric progression in which the ratio is from 3 to 3.75 consequently as the magnitude decreases the total light increases One curious result of this is that we get over twenty times as much light from stars we cannot see with the naked eye than from those we can see

The estimates of the total light received from the stars vary widely Newcomb's experiments would put it in the neighborhood of about $^1/_{80}$ of the light of the full moon Prof Young put it as high as $^1/_{60}$ Newcomb's estimates up to the tenth magnitude are interesting and I shall quote them Taking the light of all those of the first magnitude as unity 1st magnitude = 1; 2nd = 1 4; 3rd = 2; 4th = 2 8; 5th = 4; 6th = 5 7; 7th = 8; 8th = 11 3 9th = 16; 10th = 22 6

Stars from magnitudes 1 to 6 are naked eye stars, and their proportion of the total light is 16 9 units, only about $^1/_7$ of the total light up to the 10th magnitude,

As we estimated that the naked eye stars give about $^1/_{30}$ of the total light received from all the stars and the stars down to the 10th magnitude give five times as much, it is evident that all the *stars must* give four times the light of those down to the 10th magnitude, and consequently the stars below the 10th magnitude give three times as much light as those from 1st to 10th

It is very clear then that we would not suffer a very serious diminution of sky light at night if all the stars that delight our unaided eyes were blotted out, while the extinction of the telescopic and photographic stars would be a very serious deprivation Another instance, by the way of the importance of unseen things Who can say but that higher senses or a better development of our present senses might not reveal other and more important unseen influences than the light of the stars,

I might say in parody of Hamlet "There are more things in heaven and earth, Horatio, than are seen by your astronomers."

I need say little about the ordinary methods of observing star magnitudes.

One is by naked eye comparison, but more important scientifically are the extinction method by means of a *wedge of neutral tinted glass, and the equalization* method in which the polariscope is employed.

The photographic method is less employed, and being also less well known deserves fuller mention

Photography has been probably the most important of the sister arts or sciences which have been pressed into the service of astronomy It has enabled the astronomer to penetrate into the depths of space far beyond the ken of our largest visual telescopes, it has made possible the charting of the heavens in a manner impossible by the laborious method of visually observing and charting individual stars, and now it comes to our aid in stellar photometry

When, however we consider that what *we* see in a star and what a sensitive dry plate sees are quite different things, it is at once evident that photographic magnitudes are not always strictly comparable with visual magnitudes

The blue end of the spectrum and the ultra violet most affect a dry plate, while our eyes give greater value to the orange and red end of the spectrum and it is impossible to make our plates exactly take the place of eyes even by the use of colored screens and orthochromatic plates Still photographic estimations of the stellar magnitudes have their value since the results in the case of bright stars follow very closely the visual estimates, and in any case we have a record of the relative standing of the stars observed as regards the blue and ultra violet rays they emit

Photographic magnitudes are estimated in different ways. The first is by observing the effects of irradiation To make this method clear to you consider an analogy

If I throw a small stone into a pool of soft mud it will make a little splash If I throw in a large stone it will make a big splash, and stir up the mud in a much wider circle than did the little one Now weak light and strong light produce much the same effect on a photographic plate as did the stones on the mud

Most view photographers have had good pictures of interiors spoiled by the strong light from some window making a "halo" round about the window frame A point of light from a star acts in the same way and if the exposure is long enough the light is reflected from particle to particle of the emulsion in such a way that the star image is enlarged to a circle It is evident that bright stars make a greater splash as it were on the plate than faint stars, and so by measuring the diameters of these images we can estimate the relative photographic magnitudes of the stars that made them

Another plan is to move the plate slightly inside the focus of the lens, giving the star the appearance of a luminous disk The luminosity of these disks will vary of course with the brightness of the stars observed, and by measuring the opacity of the silver deposits formed on the plate the relative magnitudes of the stars observed may be estimated

The usual method of observing is to photograph the desired stars when they are at the altitude of the pole and then on the *same* plate and with the same exposure photograph the pole star and a certain sequence of standard stars around it The standard stars and stars to be observed are easily identified by taking separate photographs of each, superimposing these on the double-exposed plate and marking the desired stars The double exposed plate may now be examined and the magnitudes of the observed stars estimated by comparison with the stars of the standard sequence.

Attempts have been made to secure an absolute scale of photographic magnitudes You will have noticed that in the above method the magnitudes are obtained by comparison with stars of previously determined magnitudes. This is not always a very convenient method, and besides some day our standards may have changed their brightness If, therefore, we can adopt a standard of comparison which can at any time be reproduced by laboratory experiments a great advance has been made, for any observer in the distant future can always compare our determination of magnitudes with his own, as the possession of the data is all that is necessary to the reproduction of the standard.

Messrs. Parkhurst and Jordan, of the Yerkes Observatory have recently tried a method of obtaining absolute magnitudes with much success.

Their process was to illuminate different parts of a photographic plate with the light passing through a number of holes varying in size in a regular ratio and representing differences in illumination expressible in stellar magnitudes Plates have been produced in this way, and by comparing them with one of Pickering's photographic wedges the absorption curve of the wedge could be plotted and the wedge scaled in stellar magnitudes. Star images are then photographed out of focus and the plates compared in a photometer with the wedge and the magnitudes of the stars determined according to the effect their light had had on the plate. The effect of the stars on the plate is thus comparable with the light passing through holes of different diameters.

This sounds quite simple, but in that it is like a great many other astronomical observations, which are very

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simple if only rough approximations to accuracy are required, but which require all the refinements ingenuity can suggest to avoid or eliminate errors and secure those extremely accurate results which modern astronomy demands.

The originators of this method deem it useful for the measurement of light curves of variables of the Algol type and of short period variables generally

In this article the treatment of the subject has necessarily been general rather than specific, as my aim has been to give as complete an outline as possible of the whole subject and to bring together general information now unobtainable by the amateur except by reference to a considerable number of standard works and scattered papers

The Relation of Light to the Growth of Plants

How Colors Affect Vegetation

By Benjamin C Gruenberg

It has long been known that in the carbon fixation by green parts of plants the red rays of the solar spectrum seem to produce maximum results This is apparently not due to the difference in wave-length between the blue or violet rays and the red rays, but rather to the difference in the relative energy intensities of the different colored rays used in the earlier experiments With equal amounts of energy supplied, the green plant will decompose carbon dioxide as readily with light from one end of the spectrum as with rays from the other These results are however partly invalidated by the further fact that it is impossible to measure the quantity of light energy actually utilized by the chlorophyl of a leaf Since experiments have to be conducted with the live plant, the measurements heretofore have consisted of determinations of the total amount of light falling upon the surface of the leaf But different tissues of the leaf will absorb different rays in varying proportions, and it is impossible to tell what portion is absorbed by the chlorophyl bodies themselves These latter contain, in addition to the chlorophyl, other pigments, especially yellow substances that absorb blue and violet rays very strongly These pigments do not contribute to the decomposition of carbondioxid; a large portion of the blue-violet light is absorbed without being converted into chemical energy

Most of the investigators who have grown plants under lights of different colors have found a maximum of dry weight addition to the plants in connection with the red and yellow rays of the solar spectrum One or two however have found the maximum production at the other end of the spectrum According to Dr W Lubimenko of the Imperial Botanical Garden of Nikita in Russia, this apparent contradiction arises from the failure of earlier investigators to distinguish between the energy utilized by a plant in the decomposition of carbon dioxide and that used in the later stages of carbon fixation This botanist repeated a number of the earlier experiments, determining in each case the actual amount of carbon dioxide decomposed in a given time

Lubimenko used colored glasses whose actual color values were ascertained by means of the spectroscope from these he obtained a complete range of colors from the extreme of the visible violet to rays having a wave length of 0 700μ As a means of control he used plain white glass, single layers of paraffined paper and double layers of this paper As the monochromatic light filters varied as to the amount of light that they allowed to pass through the glasses were selected by means of comparative spectro-photometric tests and arranged to permit equal illumination for all segments of the spectrum The amount of light cut off by the paraffined paper was also measured by means of sensitive photographic paper it required 180 thicknesses of the paraffined paper to shut out completely the light of the sun The usual precautions were taken as to temperature sampling, etc The experiments were carried on in parallel for five different species, namely radish, bean pea, nasturtium and carrot.

The results, given in three tables, are summarized as follows:

An examination of the table shows that the maximum production did not in any case coincide with the maximum illumination the sunlight modified by one or two thicknesses of paraffined paper being more favorable to gain in weight It was also found that the relation between increase and light varied from time to time in the course of a plant s development Thus in the case of the radish the full light gave the maximum increase during the third week whereas during the seventh week this gave the lowest increase Of course the actual differences in weekly gains depended also upon the variations in amount of daylight from time to time

By comparing the results for the colored lights it may be seen from the table that the smallest gains as well as the minimum of energy absorbed was uniformly from the green light Under the green glass the plants frequently died before flowering The red light yielded in all cases a maximum of energy for the decomposition of the CO_2 but, with the exception of the bean all the plants gained weight more rapidly under the blue glass than under the red

The anomaly in these results is explained by Lubimenko by assuming that the light plays a double rôle in the work of photosynthesis A strong light is first active in decomposing the CO and in the synthesis of the first organic product but the further assimilation of this first product requires a light of lower intensity The amount of carbon fixation depends upon the energy that effects this assimilation of the materials elaborated by the leaves Accordingly the gain in dry weight that a plant makes will be determined by a number of factors in addition to that of light intensity The chlorophyl apparatus is capable of doing a certain amount of work but the actual amount of work done will depend also upon the needs of the organism The amount of work it is capable of doing is far in excess of the needs of the organism

Lubimenko also thinks it likely that the lights of different wave lengths particularly the red and the blue have specified functions in the photosynthetic process The red rays serve to break up the CO and water and to recombine the elements into the first organic product The other rays absorbed during this stage of the process are of no use whatever to the plant For the assimilation of the organic matter formed into the substance of the plant, there is then needed a light of low intensity It is here that the blue rays serve specifically Since it is probable that the chlorophyl is also functional in this stage, the absorption by the chlorophyl of the blue rays is explained

These suppositions of Lubimenko s are partly in general agreement with what has been long known about the physiology of carbon fixation and of plant growth Plants exposed to very intense light do not grow as well as they do under moderate illumination This is shown by the rapid elongation of the shoots of plants kept in the dark as well as by the bending of plants that are illuminated from only one side The plant in such cases bends toward the source of light not because "it seeks the light," but because the darker side grows more rapidly than the lighter side It is not necessary however to make the further assumption that the chlorophyl apparatus participates in the assimilation of the carbohydrates, or that light is essential to the process It is a well known fact that plant cells supplied with nutrition will continue to form new tissues in the dark This is seen not only in the growth of underground portions of plants or of growing layers under the bark of trees, etc, but also in the case of plants kept in absolute darkness, but supplied with nutrients

Illumination	Radish		Bean		Pea		Nasturtium		Carrot	
	Energy Taken Up	Increase in Dry Matter	Energy Taken Up	Increase in Dry Matter	Energy Taken Up	Increase in Dry Matter	Energy Taken Up	Increase in Dry Matter	Energy Taken Up	Increase in Dry Matter
White Light— Full illumination	100	100	100	100	109	100	100	100	100	100
One thickness of paper	88	116	90	119	91	108	82	113	82	101
Two thicknesses of paper	66	126	74	108	7	101	72	148	—	137
Colored Light— Red	22	5	16	26	84	30	3	15	20	4
Orange	18	2	9	12	21	22	30	9	1	
Green	1	0	1	0	2	0	4	8	0 2	
Blue	18	6	13	28	22	41	24	29	16	7

As a basis for comparing the relative amounts of energy taken up in the decomposition of CO, the actual quantity of the gas decomposed was determined For each of the seven conditions of light a specimen was prepared in a vessel containing a mixture of air and CO_2 having from 10 to 12 per cent of the latter These were exposed to the sunlight, and the amount of CO_2 remaining in each vessel at the end of one hour was ascertained The five species of plants experimented upon differed among each other with respect to the quantity of CO_2 decomposed in an hour by a given amount of leaf tissue exposed to direct sunlight, from 69 7 volumes in nasturtium, to 97.6 in the case of the carrot.

To determine the increase in dry weight, samples were taken from each lot at intervals of several days and the gain found by actual drying and weighing.

According to the theory of Baeyer, carbohydrates are formed by the polymerisation of formaldehyde which results from the decomposition of CO_2 and water In accordance with this theory experiments have been made to determine whether a green plant can derive any nutriment whatever from formaldehyde Bokorney succeeded some three years ago in getting water cress to grow under a glass jar over a solution of caustic soda containing small amounts of formaldehyde—that is to say in an atmosphere free from CO Indeed, in this experiment the assimilation actually proceeded without oxygen and without light!

It is possible also that the amount of CO that disappeared in these experiments of Lubimenko s is no certain criterion of the energy absorbed by these plants under normal conditions That is the fact that CO, was present in such large excess may have led to its decomposition out of proportion to the power of the plant to make carbohydrates At any rate it is possible to interpret these figures without assuming a specific function for the rays of short wave length

These results are not in complete harmony with those obtained from some experiments on sugar production carried out in Idaho during the past two years (Sci Am Supp No 1834, last page) where the maximum growth and productivity was correlated with the highest illumination This disagreement may be explained as due to the specific susceptibility or tolerance to light exhibited by different kinds of plants

Cathode Rays in Telephotography

Cathode rays are deviated by a magnet instantaneously This fact has been utilized by Dieckmann and Glage in the construction of a telephotographic receiver destitute of inertia A pencil of cathode rays is defined by a diaphragm having a fine perforation This pencil is acted upon by two pairs of electro magnets which displace it in two mutually perpendicular directions and which are operated by two current components determined by the movement of a stylus at the transmitting station The result is that the pencil of cathode rays imitates every movement of the stylus instantaneously and thus produces, in a plate of chalk or other fluorescent material a luminosity which appears to the eye as a continuous line comprising all the successive position of the luminous point In the construction of the transmitter an artifice which has long been used in telautography is employed to resolve the motion of the stylus into rectangular components and to translate these into current strengths

The following modification of the process has a certain practical importance The electro magnets operated by a small dynamo provided with a voltage regulator are so arranged that they throw the pencil of cathode rays into regular oscillation in a vertical plane Each vertical oscillation is followed by a small horizontal displacement so that the phosphorescent point describes a series of parallel lines very close together In this way the phosphorescent point explores, in about 1/10 second an area 3 centimeters (1 2 inches) square In consequence of the persistence of impressions on the retina, the entire square appears luminous The transmitter contains a square of the same size which is explored successively by little metallic brushes in synchronism with the receiver These brushes are connected to one pole of a battery the other pole of which is connected through the line wire to two coils which serve to deflect the cathode rays at the receiving station The other ends of these coils are grounded A pattern or stencil of sheet metal connected to earth is laid on the transmitting square beneath the little brushes which as they traverse every part of the pattern close the circuit so long as they rest upon the metallic portions When the circuit is closed the cathode pencil is deflected so that it does not fall upon the receiving screen consequently the phosphorescent point traces on the screen only those areas which correspond with the cut-out portions of the stencil The whole operation is repeated indefinitely and consequently the picture can be viewed as long as desired With this arrangement each element of the image is produced in 1/5000 second The inventors of this process intend if possible to utilize aerial electric waves for transmission in order to eliminate perturbations due to conductors — *La Nature*

Recent Finds in Archæological Research

It is reported from Naples that during the recent excavations at Pompeii there was discovered the petrified body of a young woman upon which were jewels of great value Among these are bracelets and necklaces and other jewels showing that this must have been a person belonging to the patrician class Two earrings each composed of 21 pearls arranged in clusters were especially remarkable Besides their intrinsic and artistic value, they have a great interest from an archæological standpoint, as no others of the kind have been found at Pompeii We also note that at Brescia there were lately discovered the remains of a small necropolis of the Roman epoch, and up to the present 22 tombs are uncovered These date from the time of Augustus They contained no human remains other than dust, however but some interesting objects were found among others, vases of different forms and bronze necklaces of fine workmanship All these objects are well preserved

The Natural Tunnels of Laos

A Chinese Subterranean Watercourse

Cammon, a province of Laos in French Indo-China contains many extensive beds of ancient limestone, bordered by dikes of lava which in several places have been perforated by mountain torrents in their impetuous descent to the Mĕ Kong river. There are seven of these natural tunnels or subterranean watercourses, having an aggregate length of about 12 miles, half of which has been explored by M. Macey of the French

DOWN-STREAM MOUTH OF THE NAM HIN BOUN RIVER TUNNEL

colonial administration who gives an account of his researches in a recent issue of *La Nature*. The chain of these tunnels having a total length of more than 4 miles, through which the largest stream flows, and the subterranean portion of the smallest stream more than one mile in length are still entirely unexplored. The tunnels of the streams Sĕ Bang Fai (2½ miles long) Nam Hin Boun (2½ miles) and Houci Khi Heup (1¼ miles), have been completely explored.

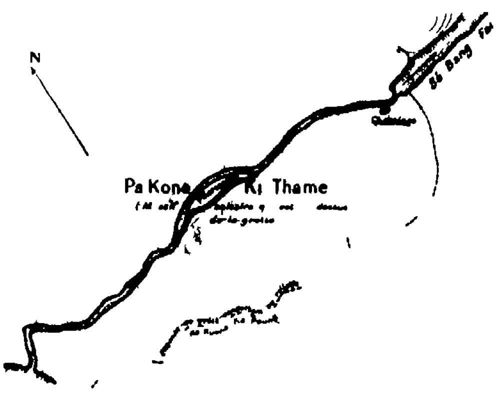
In August, 1904, a government steamer ascended the Sĕ Bang Fai to the down stream mouth of the tunnel 155 miles from the Mĕ Kong where a bamboo raft was constructed for the exploration of the tunnel. March was selected as the most favorable season for the exploration, as the stream was then lowest. In the shallower parts of the tunnel the depth of water varied from 2½ to 5 feet but in some of the depressions it was 26 feet. In places the stream was bordered by banks of sand or rock on which the explorers could walk with some difficulty towing the raft with a rope. Once a flood caused by a heavy rainstorm suddenly raised the level of the stream more than three feet and in a few minutes carried the raft several hundred yards down stream, undoing an hour's hard work. The storm continued 24 hours and three days elapsed before the water had subsided sufficiently to allow the explorers to proceed. Several rapids were also encountered. Twenty one hours of actual progress (in addition to the three days halt) brought the party to the double mouth of the tunnel. The lower opening was nearly submerged and the explorers made their escape by a perilous climb through the upper and larger passage. These openings are surprisingly small in comparison with many sections of the tunnel. Extremely high floods had left their marks on the face of the cliff 65 or 70 feet above the water or

DOWN-STREAM MOUTH OF THE SĔ BANG FAI RIVER TUNNEL

about 35 feet above the top of the upper opening. At this point the river is about 250 feet wide and is bordered by nearly vertical cliffs which extend upstream more than a mile on one side but only 200 yards on the other. Its source is some 50 miles distant.

The course of the Nam Hin Boun River is entirely confined to the alluvial plain of the Mĕ Kong and bends at a right angle in its underground part. This tunnel is frequently used as a subterranean waterway by the natives when the water is low. In the rainy season it is made impassable by a seething torrent which makes a terrific noise. In its underground course of 2½ miles the stream descends more than 100 feet by several rapids, which make portages necessary, even in going downstream. The voyage is made in light canoes, with bundles of bamboo attached to their sides, and occupies about 2½ hours in descending, and an entire day in ascending. The tunnel is very irregular in height and width, and exhibits a great variety of curves, straight lines and bends. At low water the greater part of the journey can be made on foot, on the sand banks and ledges of rock that border the stream, but the path is so rough that boats are generally preferred, even in going upstream, and the banks are used only at portages.

The Houci Khi Heup is a small stream, only 7 or 8 miles long which traverses a bed of limestone by a tunnel about 1¼ miles long, near its confluence with the Nam Hin Boum. This tunnel, which was explored in 1909 is the most interesting of all and no description or picture can give an adequate idea of the varied and majestic beauty of its masses of stalactites and stalagmites. In the dry season the depth of water varies from 16 inches to nearly 7 feet and part of the journey must be accomplished by swimming. In times of flood the water is 10 or 12 feet higher and the descent almost imperceptible, so that the tunnel can be traversed in canoes without any difficulty. The mouth by which the stream enters the tunnel is 65 feet high and 100 feet wide, but it is partly closed by a mass of rock, fallen from the cliff, so that the stream, which formerly divided into two branches inside the tunnel, is now confined to one of the channels. In floods some water forces its way into the other channel and flows on until it is stopped by a huge column of rock. This column is perforated



THE SUBTERRANEAN COURSE OF THE SĔ BANG FAI RIVER

by a bent passage about 7 feet in diameter but the floor of this passage is several yards higher than most modern floods, so that the water is stopped at this point, except in extremely high floods. The explorers walked, and even led horses through this passage. At the same point is an obliquely ascending passage which extends to the surface of the hill above. The stream emerges from the tunnel through a modest arch about 25 feet high. This tunnel of remarkable form and beauty can be traversed on foot in less than an hour in the dry season and by boat in a few minutes, in the rainy season, but several days may be enjoyably spent in exploring and studying its ramifications and lateral caverns.

Will Mankind be Compelled to Starve?

The threatened exhaustion of the world's supply of coal wood and iron is less alarming than the possibility that the earth may at no very distant epoch become unable to supply its greatly increased population with food. Already Great Britain and to a smaller extent, Germany and some other countries, are dependent upon the importation of grain. What can be done when this resource shall fail because the earth, as a whole, cannot produce sufficient grain for its needs?

At last year's meeting of the British Association for the Advancement of Science, in Winnipeg, the center of the Canadian grain trade, Major Craigie presented statistics of alarming import, showing that the population of Eastern and Central Europe has increased from 167 millions to 267 millions in the last 70 years, during which the area devoted to grain raising has actually diminished. In the years 1901-1905 the proportion of domestic production to consumption of grain was 20 per cent in Great Britain and Holland, 23 per cent in Belgium, 64 per cent in Germany and 80 per cent in Italy, and these countries annually imported more than four hundred million bushels of wheat. About half of this quantity came from Russia and other Eastern countries. As the average yield of wheat in non-European countries is only from 10 to 20 bushels per acre, an area of ten to twenty million acres was required to produce their exports to Western Europe.

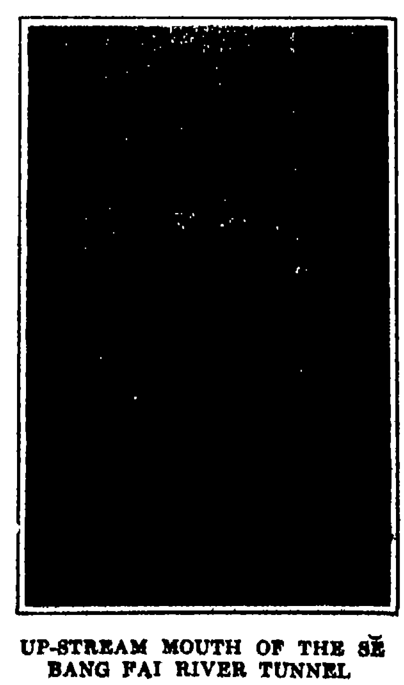
In the last 10 years the proportion of the land devoted to wheat culture has decreased from 25 to 20 per cent in Belgium, from 28 to 25¼ per cent in France, from 12 to 10 per cent in Great Britain, and has increased only in Eastern Europe. In Roumania, between 1886 to 1906 the percentage of wheat land increased from 25 to 72, and the yield per acre rose from 15 bushels in 1890 to 19 bushels in 1906 and 23 bushels in 1908. In Hungary the wheat acreage increased from 7 to 9½ millions, between 1886 and 1906. It has since fallen a little, while the yield per acre has increased.

DOWN-STREAM MOUTH OF THE HOUCI KHI HEUP RIVER TUNNEL

In France the wheat acreage decreased slightly between 1884 and 1908, but the yield per acre has risen in the last five years from 17.8 bushels to 20.2 bushels, more than compensating the reduction in acreage. The problem is less acute in France than in some other countries, as the population is not increasing. In Germany, where 4.7 million acres are planted with wheat, the yield per acre increased from 20.3 bushels in 1889 to 27.9 bushels in 1903, and has since risen apparently to 30 bushels, although this last increase may be partly due to a change in the statistical method.

In a recent issue of *Ueber Land und Meer*, Dr. Ernest Schultze quotes these statistics from Craigie's address and goes on to say that Western Europe would feel the pangs of hunger if the importations of grain from non-European countries were cut off. Furthermore, although the wheat production of the United States has increased enormously in the last thirty years, the population, and consequently, the consumption of wheat, have increased still more, so that a smaller part of the crop is available for export. In recent years Canada has become an important factor in wheat production. Contrary to expectation, the climate of the Canadian West has proved especially well adapted to the cultivation of wheat and the virgin soil of the vast prairies yields very large crops. But even these prairies are not unlimited and their fertility will soon be exhausted if the destructive American methods of cultivation are followed.

The United States and Canada, however, are not the only countries capable of producing wheat. They have already found a formidable competitor in Argentina, of whose vast area 12 million acres were planted, chiefly with wheat, in 1908. Argentina possesses 158 million acres suitable for grain production, 16 times the area now utilized. There are other countries which are



UP-STREAM MOUTH OF THE SĔ BANG FAI RIVER TUNNEL

capable of producing large quantities of grain. The wheat fields of Australia already comprise 6 million acres and the average annual exports, from 1902 to 1907, amounted to 36 million bushels. Siberia, whose climate, like that of Canada, was long misunderstood, is entering the light of grain producing lands. The production of grain can be greatly increased in Asia Minor, Mesopotamia, Sicily, Spain, North Africa and many other

regions, which in ancient times were called the granaries of Europe. Even Russia is far from being completely under cultivation. Immense quantities of grain can be produced in Manchuria, in India (with irrigation), on the table lands of Central Africa, and elsewhere. All of these lands, even if they yield only 12.7 bushels per acre, which is Sir William Crookes' estimate for the present wheat fields of the world, will supply food for a vastly larger population than the world now contains.

But the question of a possible shortage of wheat occurring within a comparatively short time cannot be dismissed so easily. Two years ago Prof Silvanus Thompson predicted that this shortage would be felt in 1921, ten years hence. His prediction was based on the following considerations: The present wheat fields of the world comprise 240,000,000 acres and produce 3,000,000,000 bushels annually. The annual consumption of wheat is equivalent to 4.5 bushels per capita of the wheat-eating population. Hence the average wheat crop is sufficient for 660,000,000 persons. The wheat-eating population, including the white race and a few fragments of other races, already numbers 585,000,000, and Prof Crookes has estimated that in 1921 it will have increased to 671,000,000, 11,000,000 more than the present crop can supply. In 1941 the white race will have increased to 819,000,000.

Thompson, however, overlooked the fact that the yield per acre can be increased, and that it has been increased in many regions, as the population has became denser and land more valuable. In the nineteenth century the area of the wheat fields of Germany was doubled and the yield per acre increased seventy per cent, so that the annual wheat production at the end of the century was nearly three and one half times what it was at the beginning. The increase in the yield per acre between 1899 and 1903, already mentioned shows that the maximum crop has not yet been attained. The improvement has been brought about by more rational methods of cultivation, selection of seed, increased use of fertilisers and the introduction of machinery, and still better results will yet be obtained.

It is certain then that the world's wheat crop can be greatly increased, and it is equally certain that the increase will be produced almost automatically as the value of land rises. This process, which was strikingly illustrated in the nineteenth century, is now taking place in the United States beginning in the east and gradually progressing westward. The American farmer is being compelled to cultivate a few acres well, instead of cultivating many acres poorly. The process will be repeated later in Argentina, Siberia, and other wheat-producing countries.

No wheat famine therefore, is likely to occur within the next few decades but no man can predict the conditions that may prevail at the end of the twentieth century.

A New Wireless Transmitter

The Lorenz System Briefly Described

THE Lorenz company has constructed a new direct current wireless transmitter the description of which will be made more intelligible by a recapitulation of what has already been done in its special field. The review and description are condensed from an article by Dr G Eichhorn, in the *Illustrite Zeitung*.

In 1906, undamped or sustained electric oscillations, produced by Poulsen's arc device, were first employed in wireless telegraphy. A receiver with minimum damping then became a desideratum and the Poulsen Pedersen "tickler" was found to give a remarkable and previously unattained facility in tuning and freedom from disturbance. Then came from America the method of increasing the sparks of the ordinary spark transmitter to such an extent that they throw the telephone membrane of the receiver into regular vibration and produce a musical sound which can be clearly distinguished from the effect of atmospheric disturbances in many cases and even from other wireless signals in favorable conditions. This idea was taken up by Gesellschaft fuer drahtlose Telegraphie. Poulsen had already devised a method of dividing his undamped oscillations into equidistant groups, which produce a very clear and easily varied and regulated tone in the receiver. This method has hitherto been employed for short distances only owing to the want of an interrupter suitable for use with very strong currents.

The same advantages are possessed by a method of

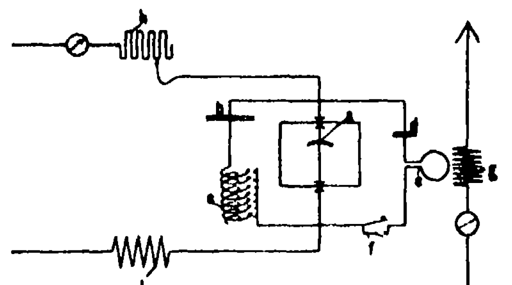


FIG 1.—A NEW WIRELESS TRANSMITTER

producing the oscillations by causing two oscillating currents, each including a luminous arc generator and slightly out of tune with each other to act upon a single antenna circuit. Oscillations produced in this way also evoke very clear and distinct tones, the pitch of which can be conveniently regulated, but only at comparatively short distances.

Two expedients have been tried for the purpose of increasing the range. In one system the arc circuit is traversed by a direct current and also by an alternating current, which periodically influences the oscillations produced by the arc. In the second system the arc is replaced by a short spark gap and the direct current is reinforced by an alternating current, furnished preferably by a Duddel oscillatory circuit, by modifying which the pitch of the sound produced can easily be varied. This system is especially well adapted for portable stations. The arrangement of the transmitting apparatus is shown in Fig 1. The spark gap *a* is formed by two electrodes of nearly spherical curvature, one convex, the other concave, the distance between which can be varied. An atmosphere containing hydrogen can be maintained between the electrodes by letting fall between them, by means of an automatic dropper, drops of alcohol, which are instantly volatilised. The Duddel circuit contains a large condenser *b* and an inductance coil *c* having a core composed of strips of thin sheet iron. This coil is divided into a number of sections, which can be opened or closed separately for the purpose of varying the self-induction of the coil. Connected in parallel with the spark-gap and the Duddel circuits is a third, called the impulse circuit, containing a small condenser *d*, a key *f*, and a few turns of wire *e*, which act by induction on the coil *g* of the antenna circuit. The discharge through the spark-gap is regulated by the variable resistance *h* and the adjustable choking coil *i*. This discharge is triple, being composed of the direct current from the dynamo or battery, the low frequency alternating current of the Duddel circuit and the high frequency current of the impulse circuit. The first and second components combine to form an alternating current which produces periodical variations in the resistance of the spark gap. When this resistance is high a series of high frequency unidirectional discharges from the antenna is produced but when the resistance of the spark gap is low and the current through it is a

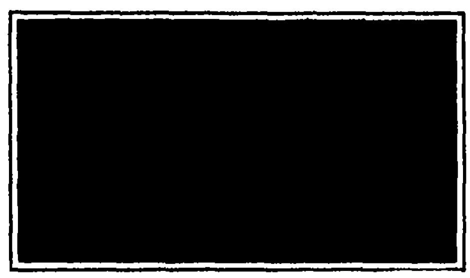


FIG 2.—GROUPS OF PARTIAL SPARK DISCHARGES

maximum the antenna circuit remains unaffected. The effect of the introduction of the Duddel circuit, therefore, is to interrupt periodically the flow of high frequency discharges which would be emitted by the antenna and thus produce in the receiving telephone at the distant station a continuous tone having the pitch of the Duddel circuit.

The apparatus is very light and its operation is exceedingly simple. By manipulating the contacts of the sections of the inductance coil *c* and leaving the key *f* closed, various tones can be produced and trumpet call signals and even melodies can be transmitted. Morse signals can be transmitted in any of the possible tones, by manipulating the key *f*. The voltage employed for the spark gap does not require nice adjustment, the inductive connection between the impulse circuit and the antenna admits of wide variation and these two circuits need not be accurately in tune with each other.

Four groups of high frequency discharges through the spark gap, alternating with intervals of darkness, are illustrated in Fig 2 while Fig 3 shows the last four discharges of a group and Fig 4 the first discharge of the succeeding group.

Toncan Metal

By F M ENGLISH

THE development of Toncan metal was undertaken to meet the demand for a black or galvanized sheet which would be moderate in price and have the highest corrosion resisting qualities for use in roofing, siding, eaves trough, conductor pipe, and for all other building purposes into which such sheets enter.

In undertaking the development of a sheet of this character, the manufacturers have been guided throughout by

FIG 3.—THE LAST DISCHARGES OF A GROUP

the old-time iron master and by adapting old-time principles to modern methods as far as possible.

The problem of the iron master in making the quality of sheet which he did was infinitely simple as compared to the one facing the modern iron or steel maker, who undertakes to reproduce sheets having the corrosion resisting qualities of the old-time goods and which also combine all the other qualities requisite in a sheet which must meet modern requirements.

Had we to-day the same raw materials, the same workmen the same furnaces and exactly the same conditions, sheets could be made in all respects equal to any that have ever been made but could the manufacturer with such facilities begin to supply the present enormous demand and could he reproduce sheets at a price which would permit of their use in the vast variety of ways in which sheets are now being utilized?

To meet the present day demand for sheets—to enable the mills to keep pace with the ever increasing consumption because of the infinite variety of ways in which sheets are being employed—the slow limited methods and processes of the past cannot be employed or reinstated.

The problem now confronting the sheet manufacturer is how to make sheets having the old time corrosion resisting qualities together with the necessary working qualities and at a price which will not curtail their use. And it is no easy one. In other words the sheet manufacturer must now make two dozen blades of grass grow" where one grew formerly not at the same price and of the same quality but at a lesser price and of better quality and with higher labor inferior raw materials, and to withstand much more exacting conditions.

The conditions to which sheets are now subjected as compared with earlier times are also entirely different—

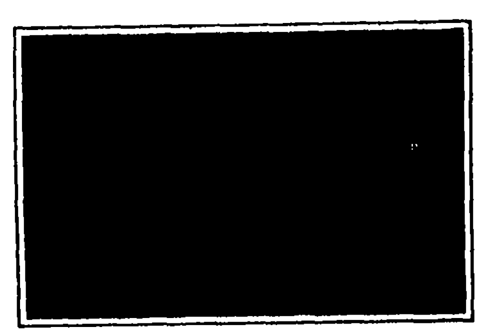


FIG 4.—THE FIRST DISCHARGE OF A GROUP

the demands and requirements of trade are far more exacting. The sheet of to-day to meet modern exactions, must have not only the highest corrosion resisting qualities, but they must have working qualities also, and be able to withstand strains and stresses in shaping, forming and handling never dreamed of in the past, to say nothing of the vastly changed atmospheric demands to which they are now subjected. The sheets of the present time, to meet all requisitions must be better than the old time ones and not only better but cheaper.

In placing this new rust resisting metal on the market as a material in which are combined all the qualifications necessary in the modern sheet, whether galvanized or black, it is classed as a metal rather than as an iron or steel, because while it has corrosion resisting qualities equal to the old time iron it also combined many characteristics of the highest grade mild open hearth steel, making it the ideal material with which to meet all requirements of the latest sheet metal practice, in that it will not only withstand corrosion but also the strains and stresses of shaping and forming without fracturing.

It is an undisputed fact that the corrosion-resisting qualities of the early sheets were due entirely to their uniformity or homogeneity which was made possible by the proper selection of raw materials through the principle involved in their handling and through the care and attention with which the iron was made. Plenty of time was given with the raw materials while in the furnace, to eliminate any excess foreign impurities present and to properly combine those remaining and also by handling the iron after it came from the furnace in such a manner that segregation did not take place during the reheating or working up processes.

Through modern research and investigation we know that corrosion is caused by the carbon sulphur phosphorus and manganese becoming segregated, during the process of manufacture this theory having been fully demonstrated both in the laboratory and under actual

working conditions the corrosive action taking place in the following manner:

When the impurities carbon sulphur phosphorus and manganese become segregated in iron or steel that is when they are not equally and evenly distributed throughout the metal occurring in small spots or areas, an electrical current will be set up between these segregated points whenever the sheet in which they are present, becomes covered with a film of moisture from the atmosphere Due to differences in composition some of these points of segregation become positive others negative which when connected by the film of moisture set up numerous electrical batteries of greater or lesser energy according to the extent of the segregation so that there are limitless numbers of small electrical batteries continually at work throughout the sheet It is a well known fact that a current of electricity cannot be generated in a battery without destruction or dissolution taking place at the positive pole so that in any sheet iron or steel in which segregation has taken place and the surface of which through exposure to the atmosphere has become covered with a film of moisture, there are numerous small electrical batteries at work at the positive poles of which the iron or steel is being destroyed resulting in the form of corrosion known as pitting a form with which manufacturers are all only too well acquainted The more marked or strongly defined is the segregation the stronger will be the electrical action; consequently the more rapid will be the destruction of the metal or sheet On the other hand the less well-defined the segregation the weaker or milder will be the electrical action and consequently the life of the sheet will be longer Again in a well made sheet of iron or steel in which the impurities have been properly incorporated and segregation reduced to a minimum the electrical action will be so slight that pitting will not take place but instead an even coating of rust will be formed over the entire surface of the sheet in such a way that the rust will itself become to a great extent a protective coating greatly retarding the process of decomposition or rusting It was for this reason that the old time iron sheets withstood so phenomenally the ravages of corrosion It was not because they did not rust that caused them to last but the way in which they did rust that made them so long lived

No iron or steel has ever been made or can ever be made that will not rust in moist air because it is the nature of all products made from iron ore to rust and in time return to the natural state from which they originally came. But the way in which the rusting takes place can be controlled, thus making the sheet long lived, durable and the most ideal metal for roofing, siding, eaves trough conductor pipe and other similar purposes

It has generally been supposed that steel corrodes faster than iron, also that pitting is confined entirely to steel, but this is by no means the case. Both iron and steel pit and corrode, and badly made iron, of which we are getting a great deal to-day lasts no better than badly made steel The opposite of which is also true, namely, that properly made steel will withstand corrosion and pitting equally as well as iron, besides having far superior working qualities

There may possibly be some question as to how electrolysis takes place in causing corrosion as regards the exact chemical reactions but that electrolysis actually does take place, and that it is the true cause of corrosion cannot be successfully disputed The fact that electrolysis does occur is proven conclusively by the ferroxyl test exhibits of which all manufacturers have examined The object of this test is not to show the comparative lasting qualities of two or more pieces of metal, but only to prove the theory of electrolysis by practical demonstration

The explanation of the test is this: At the poles of all electrical batteries two elements are always found to be present namely hydrogen ions and hydroxyl ions The hydrogen ions cluster around and indicate the positive pole The hydroxyl ions in the same manner indicate the negative pole The ferroxyl testing reagent is composed of certain indicators, the reactions of which when brought into contact with these two elements, have been known for years Ferroxyl is a weak acid, and is of such a nature that when brought in contact with hydroxyl ions it at once produces a pink color while potassium ferricyanide when hydrogen ions are present, causing iron to be dissolved or corroded produces a blue reaction Both of these chemicals are present in the gelatine mixture in which are embedded the samples which you have examined the blue color indicating the positive poles where destruction or corrosion is taking place, the pink color indicating the negative poles No piece of iron or steel has ever been found which, when subjected to this test will not sooner or later develop the pink and blue reaction which all have witnessed

The point involved then in the manufacture of iron or steel which is to resist corrosion is to so combine and work up the raw materials that these electrical currents, which cause corrosion, will be of the mildest form and whose action is not concentrated or fixed through excessive segregation.

Of the many subjects which are of interest to the sheet metal worker and the user of sheets there is none of such vital importance as the subject of corrosion, and what affects the sheet manufacturer, so that the cause and cure of corrosion is of common interest to both

If the sheet metal business is to grow, expand and assume the position in the world of business which it should, it is absolutely necessary that the sheet metal workers strive in every way to use only such sheets as will stand up for at least a reasonable length of time and to avoid wherever possible the use of goods that will prove disastrous to his business and his reputation Manufacturers of sheets have long recognized this fact, and for a considerable time a company at Canton, Ohio, has been carrying on a series of exhaustive tests and experiments to produce a material which would be reasonable in price and meet all requirements—both as regards corrosion resisting qualities and working qualities—thus placing within reach of every worker of sheets a material with which to combat and overcome the ever increasing prejudice against sheet metal for building purposes, a prejudice which has, of late years, been steadily increasing, due to the unsatisfactory lasting qualities of a large majority of the materials which are now on the market.

The result of these efforts is rust resisting metal, a material which combines the essential qualities of high corrosion resistance ductility, and moderate cost. A long series of acid salt and creosote tests have been carried on in addition to carefully noting results of exposure to actual every-day working conditions.

With the necessarily incomplete outline of the qualities and characteristics of this rust resisting metal, and of the subject of the corrosion of iron and steel, we leave the subject, hoping it will receive from the sheet metal worker the further consideration which is its due. The subject is certainly one of vital importance to every sheet metal worker because the development and growth of the industry will be determined largely by the degree in which corrosion is manifested in the materials adopted and used The employment of highly corrosive material will retard and lessen the demand for the sheet metal work while the use of better and more lasting material will stimulate and encourage the demand

The Aggregation of Power Systems*

Economic Limitations of the Big Power Station

By Robert A Philip

Limitations on the distance to which power can be transmitted electrically have been investigated from time to time In this paper it is the purpose to point out that the limiting distance of transmission is not the limit of economical interconnection and that there is probably no such limit It is also the purpose to outline certain principles of electric transmission which indicate the line along which unlimited extension of electric net works may proceed

Electric power promises to become the universal power of the future It is not a substitute for steam power or water power It competes with no prime mover Electric power is essentially a secondary power Prime movers produce useful but crude mechanical power from the rough irregular forces of nature Mechanical power transformed and refined in the electric generator, becomes electric power the highest known form The highest form because it can be changed to other forms heat light motive power chemical action with unparalleled directness and simplicity It is the uniform method of applying any kind of power from any source to any work To other powers it stands as a common medium of exchange Prime power is like property electric power like money

The electric motor consumes electric power produced by an electric generator driven by a prime mover When an electric motor is substituted for a steam engine the load is merely transferred from one prime mover to another There is a loss of power in the electric generator a loss in the electric transmission line and a loss in the electric motor In spite of these losses electric transmission and distribution of power is commercially successful because of economy flexibility and cleanliness

The motor is economical merely because the prime mover on which it ultimately depends is still more economical; that is electric power is an advantageous means of producing competition between different prime movers and thereby displacing those that are wasteful Every circumstance unfavorable for economical power generation can be found in varying degrees among isolated plants while central electric generating plants may take advantage of every practicable economy Certain highly important differences favorable to centralized prime movers are greater size greater diversity factor, greater load factor convenient location for fuel and water and cheap land Of these some are automatically cumulative As the plant grows its economy increases, and as the economy increases it surpasses that of more and larger isolated plants, displaces them and thereby grows some more Furthermore, electric power is not limited to bringing a large prime mover into competition with a small prime mover of the same kind; it goes farther, taking for its source any other kind of prime mover which may be more economical The economy of electric power is essentially progressive and is only limited by that of the best prime mover of any size any kind anywhere

Power is used to produce results The requirements for economical production and economical application of power are antagonistic Concentration and continuity are essentials for favorable production while subdivision and controllability best adapt it to its uses Electric power reconciles these diverse requirements While concentrated at the continuously running generator it is subdivided at the intermittently running motors

Essentially a secondary power it consumes no raw material and emits no waste material No water or fuel goes in no ashes water or gases come out Increased human activity and efficiency require and depend on increased power per capita per square mile per cubic yard Contamination of the air by prime movers sets an artificial limitation to beneficial concentration Electric power removes the limitations and opens up new possibilities The modern city subway can be operated by electricity and by that alone

The principle underlying the success of electric power is that of uniformity Incidentally to be uniform, the method must be indirect The same principle underlies the use of money Property may be exchanged directly by barter but the uniform method of indirect exchange by purchase and sale is superior In each case the intermediate medium of exchange gives the flexibility necessary for equalising production and consumption on a large scale The public service corporations which distribute power have a function analogous to a banking system They constitute clearing houses for balancing the individual increases and decreases of power requirements of a community as a whole and provide a centralized reserve for meeting promptly any total net increase

The power plant which does not use electric power stands alone In the continual readjustment of industry there are shifting deficiencies and surpluses of power which cannot be economically met by increasing, decreasing and moving local prime mover power plants In the aggregate, the disproportion of the isolated prime movers to their loads must be enormous. This leads to the conclusion that there is a great collateral advantage in using electric power, wherever practicable as an intermediate step between the prime mover and the work, thereby providing the necessary means of immediately and without further expense participating in the advantages of uniting resources with the rest of the community whenever emergency, convenience or economy require it.

The success of electric power distribution and transmission has been due largely to two specific applications of the underlying principle of uniformity First, that it is cheaper to generate power by steam in one large plant than in numerous little plants. Second, that steam power may be economically superseded by otherwise impracticable water powers These two applications have built up two classes of transmission systems those from central team plants originating at the large centers of population and radiating into the country where they supply current for railways light and power in outlying towns and villages; those from water powers starting from the mountains and converging toward the cities These applications alone though stimulated by increased consumption and higher price of fuel, may extend the economical radius of transmission, but not indefinitely

On the other hand if there is no increase in the economical radius, nevertheless the continued development which may be reasonably expected along present lines will in time cover the country with high tension distribution and transmission lines These lines will form short contiguous but independent transmission systems, each one having a specific function of distribution or transmission which pays for the interest on the investment, the repairs and maintenance and the cost of power used up in core loss and other friction or leakage necessary for keeping the system alive While each line is useful and necessary, every line is subject to periods when it is idle In other words its load factor is low During off peak hours, power can be transmitted subject to no charge for interest, repairs or maintenance and free of deduction for the constant losses of the system Devoid of these encumbrances, the usual limitations to the distance to which power may be transmitted do not hold.

This opens the way to a broader application of the principle of uniformity The differences in economy between large and small steam plants and between steam and water power plants are not the ultimate limitation to transmission Were the limitations reached in these two directions there remains a vast field of economy in applying the principle in other directions

Diversity factor alone contains almost inconceivable possibilities Whenever there is intermittent work diversity factor may be expected In so far as it is unnecessary to do two different things simultaneously it should be unnecessary to duplicate the power supply Since the point of application of electric power may be instantly transferred from place to place, only a half (or other fraction, as the case may be) of the prime power is required in a central plant which would be needed in two or more separate local plants This fraction is the diversity factor It has already done much to enhance the advantage of the large plant over the small one, but the large plants in turn are governed by local conditions and, like the isolated plants they supplant, they have important diversity factors among their loads. Thus the conditions determining the hour of peak vary considerably in different cities, with the industries and customs of the inhabitants, with local weather conditions, with

*American Institute of Electrical Engineers

the altitude, latitude and longitude; the artificial convention of standard time makes an hour's difference in time of starting work in nearby cities and over greater distances the natural difference in time makes greater differences.

Water powers have a peculiar species of diversity factor of production due to non-coincidence of deficiencies. While there are dry years in which all water powers may suffer deficiency, the idea of coincident deficiencies is largely due to insufficient and inaccurate records. From the nature of the case the rains, snow fall, freezing and thawing must vary widely according to the location and exposure of the watersheds. There will be some diversity between the flow of any two streams though they be adjoining, a greater diversity between those on opposite sides of a divide and more between those on different mountain groups. A large river which runs dry for short periods for lack of storage and a large reservoir on a small stream are each defective for power supply, but together they may be mutually supplementary. By combination the bulk of the power may be derived from rivers on one watershed the reserve storage from those on another.

More remotely the general extension of transmission may open up possibilities of developing the intermittent powers of nature which, variable and unreliable in any one locality when taken over a large area, or in connection with each other or with existing developments, may be found to be uniform and reliable. Thus the tides occur at different hours and at different points. Variable powers such as the wind have appeared impracticable largely because they have never been studied adequately and if developed locally require a prohibitive expense for regulating equalizing and storage. Comprehensively developed as an auxiliary to an established system which could use the power as available, the cost of power from these sources would be far less than has been heretofore supposed.

Transmission lines are the highways of power. Having made power portable and universally applicable by reducing it to the electric form it is inconceivable that the highways over which it travels will not be vastly more useful if interconnected.

More definitely there is the present problem of existing transmission systems growing beyond the bounds for which they have been designed by the annexation of adjoining independent systems as one by one the collateral advantages pass into the domain of accepted fact.

To design a transmission line to transmit power from a water power plant to a city is a definite problem. To interconnect two such lines to accomplish some auxiliary purposes not in the original design is quite a different problem. The interconnection of two transmission systems is like combining two railroads, first, there must be a physical connection then unified operation. As the gages of the railroads must be reconciled so the frequencies, phases and voltages must be adapted by reducing to a common standard or the power must be converted at the junction points. Then the flow of power in the network must be controlled so that, within the limitations of the wires provided power may be transferred at will from points of surplus to those of deficiency. This problem of interconnection differs from that of transmission in introducing as an element the idea of reversible transmission, that is, either end of the line may be generating or receiving end.

The interconnection of two systems forecasts future connection with a third and fourth. Such extension carried on indefinitely leads to the conception of a single vast system which may be built up in the future. Electric power is successful because it is the one uniform method of equalizing supply and demand. Every extension and interconnection broadens the field in which it can act and should increase its success. Continued indefinite extension is desirable and inevitable if possible.

As electric power is like a common denominator to which all other power is reducible so alternating current is the common form to which electric power itself must be reduced to become universally available. Direct current is useful and necessary but its function for the present at least, is that of a form auxiliary to or derived from alternating current and limited in the distance which it can travel to a single locality. Alternating current combines a suitability to the high pressure necessary for transmitting power in bulk long distances with a simplicity of division and subdivision both of power and pressure which is necessary for the ultimate distribution. Furthermore, the alternating current system has unique qualities which especially suit it for reversible operation and thereby adapt it for indefinite extension.

Electric currents are commonly regarded as flowing from points of higher potential to those of lower potential. With direct currents the potential of the generating end of the line must be higher than that of the receiving end directly in proportion to the power delivered in order to overcome the line resistance. With alternating currents delivering the same power over the same line at the same voltage and at unity power factor, the potential of the generating end must be still higher as the reactance as well as the resistance of the line must be overcome even if the power is delivered at unity power factor, which is usually regarded as the most favorable case for alternating transmission. If the power is delivered to an inductive load the power factor will be lower than unity and the potential of the generating end must be higher yet in order to force the magnetizing current over the line in addition to the working current.

To provide for the variation of drop of potential in a transmission line at varying loads numerous devices are used. The generator voltage may be varied through adjustment of the field rheostat or by compounding; the ratio of step-up and step-down transformers may be made different so that the generator voltage will be the same as the receiver voltage at full load instead of at no load, as would be the case if the transformers had the same ratio; or separate boosting transformers may be used to the same end; a regulating dial connected to taps to the transformer windings may be used to vary their ratio, or a regulator consisting of a separate transformer of variable ratio may be used for the same purpose.

While in ordinary alternating-current transmission supplying only lights and induction motors the potential at the generating end is necessarily higher than at the receiving end, in a transmission line supplying a synchronous motor taking a leading current the condition may be reversed and the potential may be higher at the receiving end than at the generating end so that the current flows from a point of lower to one of higher potential.

While leading currents may cause the potential at the receiving end to be higher than at the generating end they do not do so necessarily. With a large amount of leading current the potential may be higher at the receiving end, but with a small amount it may be lower and with an intermediate amount it may be the same at the two ends and may be maintained the same even if the load varies by a corresponding variation in the amount of leading current.

Power may therefore be transmitted over a line by alternating currents without change of potential and a system may be built up by adding other lines until a network is formed uniting many power houses and many substations. In such a system the potential may be the same at the bus bars of every power house and every substation and yet power may be transferred at will through the network in any direction. Since the potential at the edges of such a network is the same as at the center it is evident that the system is capable of indefinitely great extension. While the power is transmitted without loss of potential there is a loss of energy equal to the square of the current multiplied by the resistance as usual. The possibility of extension is not for the transmission of power in bulk for indefinitely great distances but rather for the extension of a network containing points of generation at intervals the load being equalized on the points of generation by means of the network which permits of power being transmitted to or from any point in any direction for distances as great as considerations of emergency or economy may indicate from time to time.

In view of the customary drop of potential from the generating to the receiving end of the line transmission without this drop may at first seem to be an abnormal and unstable condition but this is not the case.

Suppose two identical machines connected by a line one run as an alternator and the other as a synchronous motor. If the resistances and reactances of the armatures are so small as to be negligible and if the strengths of the fields are so great compared to that of the armatures that the effect of armature reaction is negligible then this combination will automatically transmit the power with constant potential at each end of the line independent of load and of line impedance. If the armatures of the machines have appreciable resistance or reactance there will be a drop of potential from no load to full load, but it should be noted that the drop results from the resistances and reactances in the machines, not those in the line. It is therefore only necessary to improve the regulation of the machines themselves to attain a natural constant potential transmission system.

To operate a synchronous motor on the constant potential system we should therefore adjust its field not according to a power factor meter but according to a voltmeter on the line as it is normal line voltage not unity power factor on the motor which is desirable. The condition previously assumed that the synchronous motor is a machine which is a duplicate of the generator is not essential also any other kind of load may at the same time be supplied by the same line. Where both synchronous and induction motors are operated from the same line the voltmeter method of adjustment has the advantage of simplicity in that the proper adjustment of the field of the synchronous motor for overcoming the lagging currents of the induction motors is obtained thereby although the currents taken by the induction motors are unknown to the one making the field adjustment. Where synchronous motors are used on lighting systems the advantage of operating them on the constant potential system is obvious for if correctly operated in this manner the regulation of the system which is of prime importance becomes perfect.

Taking again the case of the two-machine transmission just considered. Suppose a mark made on some point of the rotor of the generator and a similar mark at the corresponding point of the rotor of the motor. At no load the marks will reach the top of the circles in which they revolve at the same time indicating that the voltage of the motor is in phase with that of the generator; as the load comes on the mark on the motor will fall behind that on the generator reaching the top position a little later indicating that the voltage of the motor is falling behind that of the generator. This illustrates the principle that in constant potential transmission current flows and power is transmitted from points of advanced to those of retarded phase. In other words, the potential of the receiving end must drop behind that of the generating end in phase instead of below it in magnitude.

In a direct-current transmission with constant generator potential the amount of power transmitted increases with increased drop of potential up to a certain maximum and then decreases again so with constant potential alternating transmission the amount of power increases with increased retardation of potential phase up to a maximum and then decreases again. In each of these cases the range from no load to the maximum load is the range of stable operation, beyond the maximum is a range of unstable operation. In each case too, the maximum power which may be transmitted depends on the constants of the line. The greater the resistance the less power that may be transmitted by either direct or alternating currents. The analogous assumption that the greater the line reactance the less the power that may be transmitted by alternating current is incorrect. With no line reactance no power could be transmitted at constant potential but as all lines have some reactance this case would never actually occur. Up to a certain limit the greater the line reactance the greater the maximum amount of power which may be transmitted. For every transmission line there is therefore a range of stable operation for constant potential transmission.

The utility of a system of transmission depends partly on the ease with which its operation can be foretold by calculation. On this basis the constant potential system is at a great advantage for its characteristics can be shown in a simple diagram constructed from constants which are readily calculated and have an easily understood physical meaning.

The constant potential alternating system is on a par with direct current as to the amount of power and as to the efficiency of transmission over a line of given resistance and voltage.

A comparatively high line reactance is a favorable feature both as regards amount and efficiency of power transmission and therefore a frequency of sixty cycles per second may be better than one of twenty five cycles for power transmission.

Reactance makes a line opaque to short circuits, but wattless power introduced at the receiving end makes it transparent to the flow of useful power therefore the power at short circuit may be less than at full load.

A short circuit may be a local matter not interrupting the service of the system as a whole not affecting the voltage except for a limited radius and not draining any extraordinary amount of power from the system.

Switches of limited capacity may be safely used on systems of unlimited power.

Blocks of power too great to be safely controlled may be subdivided by artificial lines instead of being entirely separated.

There are no limitations to amount of phase difference therefore none to unlimited extension at constant potential but in distant parts of a large system the difference may be so great that one machine may be one or more complete cycles (or even revolutions) behind another.

In interconnecting different branches of a large system the actual as well as the apparent phase difference must be considered therefore the readings of any ordinary synchronizing device may fail to indicate the true phase relation.

Constant potential transmission requires controllable leading currents synchronous motors are the practical source of such currents therefore the first step in establishing such a system is to have as large a part of the receiving equipment as possible composed of synchronous motors to have these motors designed for carrying full load with leading currents of say 80 per cent power factor and to have their voltage controlled by non compounded voltage regulators.

Rotary converters are synchronous motors but as ordinarily constructed are poorly adapted for operation with leading currents.

The electrostatic capacity of transmission lines furnishes leading currents which are not directly controllable and are therefore not the equivalent of those from synchronous motors.

Synchronous motors can take lagging as well as leading currents, but the lagging currents taken differ from those of induction motors in being controllable.

The leading currents of line capacity and the lagging currents of induction motors subtract and add respectively certain amounts to the available leading currents to be furnished by the synchronous motors, that is they do not affect the range of control required but rather shift the mean position of this range toward lagging or leading respectively.

To summarize the principles here outlined. First is that of the solidarity of the power market as a whole next is that of the place of electric power in this market which, not itself a prime power yet is the common medium of exchange for all prime power. From this follows naturally the indefinite extension and interconnection of transmission lines, the highways of power. Underlying all these is the requirement that electric power though poured in unlimited amounts into a system of indefinitely great extent must be as mobile as the trains on the country's railroad network must be universally uniform in quality must never be totally interrupted and though in amount unlimitedly great must not be uncontrollable. To meet these requirements electric power must take the alternating current form and should be transmitted on the constant potential system. Finally this system is one using high line reactance made transparent by leading wattless currents and transmitting power by displacing the phase of the voltage instead of varying its amount.

The governor of the Ubangui and Tchad regions of central Africa has lately issued regulations prohibiting the hunting of the elephant with fire arms and the setting of traps for this animal. The rules also forbid the killing of female elephants and of young immature specimens, whose tusks weigh less than 11 pounds. The elephant in Africa is not domesticated as it is in Asia, and this leads to the indiscriminate killing of the animals in order to secure the spoils. However, under such conditions there is danger that the elephant will become exterminated before long. An international conference has been held upon this question and a set of measures have been framed and recommended for promulgation.

A Gasoline Tractor of 100 Horse-power Capacity

A Mechanical Horse for the Farm

By Frank C Perkins

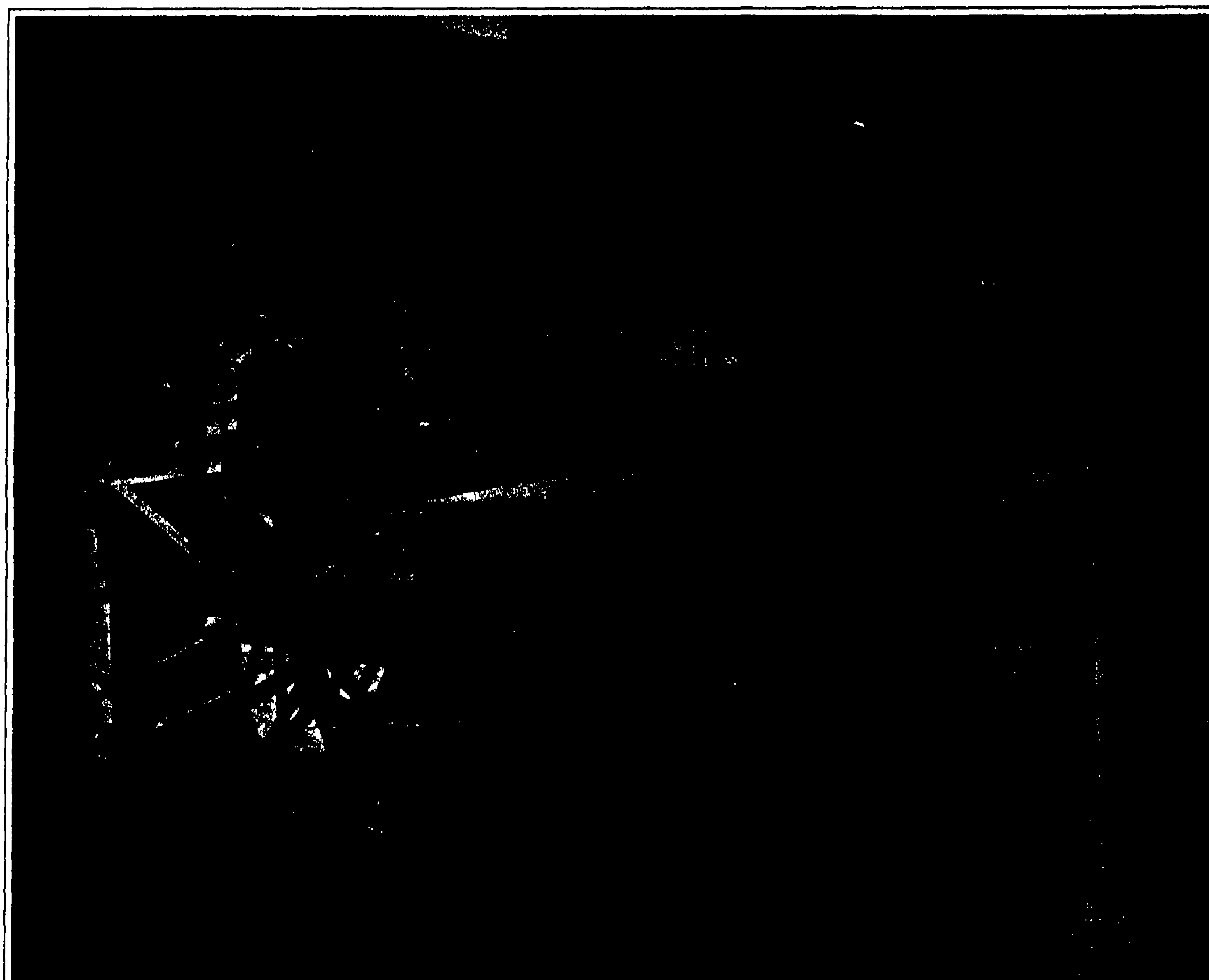
THE accompanying illustration shows the construction of a novel gasoline or oil tractor designed at Racine, Wis for use on the farm in plowing hauling and threshing or for driving saw mills shingle mills pumping machinery or stone crushers This gasoline tractor is equipped with a four cylinder motor of the four cycle type developing from 81 to 100 horse power

The piston speed is 750 feet per minute and the four cylinder engine develops 81 horse power at 450 revolutions per minute the cylinders having a diameter of 9 inches and a stroke of 10 inches The fuel consumption averages one pint per horse power per hour The crank shafts have five bearings lined with babbit, the shafts being forged of solid steel The connecting rods are through the shafting axles and boxes, which are carried by the I beams.

The design of the spring-mounting is quite an important feature in engines of considerable size On this tractor helical springs are used two in each box. The cylinders engaging the springs are cast with steel flanges at their upper ends which are riveted to the under sides of the I beams at the required position The hollow pistons which contain the springs are turned up to fit into the cylinders so as to work freely inside them. The lower end of these cylinders are forked to fit the trunnions on the axle box proper so as to allow free movement in every direction and additional springs are provided to absorb shocks when traveling over rough of the tractor so arranged that any number of plows can be attached within the range of the power of the tractor or a single draw bar may be used for hauling wagons.

Experiments with a Quartz Mercury Arc

A MERCURY arc when properly formed, can be made to rotate very rapidly This fact was brought out by Prof Dufour of Paris He uses an inverted bulb partly filled with mercury and a quartz tube is pushed up through the mercury until the end is somewhat uncovered, thus dividing the mercury into an inner and an outer zone separated by the quartz. Connecting the current to the two zones and making a vacuum, an arc is formed across the end of the tube between the two portions of



ONE HUNDRED HORSE POWER GASOLINE TRACTOR ESPECIALLY ADAPTED FOR FARM WORK

of the same material and two and one-half times the length of the stroke

The machine is self-oiling All that is necessary is to occasionally replenish the reservoir with oil a force pump does the rest The oil reservoir or splash box is made of galvanized iron and is bolted to the motor main frame being "oil tight" It can be easily removed when the entire crank shaft is exposed to view and all parts inside the crank case can be freely inspected or adjusted

The exhaust is carried by a manifold pipe directly to a very efficient muffler which completely deadens all sound without causing any back pressure The water is circulated by a powerful rotary pump and is discharged through gratings into a fan where it is effectually cooled before entering the storage tank This tank is placed on the forward part of the tractor over the front wheels

The frame is composed of I beams one on each side, with cross pieces extending between them to which they are riveted Braces are attached to the upper and lower cross pieces to prevent any twisting of the frame through the strains incident to the transmission of so much power roads The front axle is mounted on springs of the same type, and has free movement in every required direction This arrangement is neat, and works perfectly causing the machine to ride very smoothly and preventing the jarring off of nuts and the working loose of parts, so common an occurrence in engines without springs

The rear wheels are of steel, and have steel hubs. They are 6 feet in diameter by 24 inches wide The spokes are riveted to the steel hubs and to the angle iron rings inside the rims by two ¾ inch rivets at each end—put in hot by machinery

Extensions are provided to attach to the wheels for plowing on rice or cotton lands, at an extra cost, according to width The front wheels are 43 inches in diameter by 14 inches wide and are of ample strength, yet as light as it is thought safe to make them

The steering wheel is situated near the center of the length of the tractor and near the right side, so that the steersman can see the road ahead of him, and is at the same time within easy reach of the controlling levers, the clutch lever the reverse and the brake, also the carbureter switch, magneto and governors on the motor

Adjustable hitching bars are located at the rear end mercury Such arc is found to rotate at a very high speed around the end of the tube, so that it appears to the eye as a ring of light. Experiments with a revolving mirror show that the arc rotates in fact and is not continuous. He calculates the speed to be from 8,000 to 15,000 revolutions per second. This latter number is obtained when the arc is placed in a strong vertical magnetic field, by mounting the whole apparatus between the poles of an electromagnet. Here the arc changes in character and gives a brilliant light. Considered from a practical standpoint, the expenditure of current in the electromagnet does not follow the increase of light, which is an advantage.

It is reported in the *Railway Gazette* that the government of Panama have contracted with the Panama Railway Company to build a line from the city of Panama to David, the capital of the province of Chiriqui. The distance is about 274 miles, and it is expected that the route surveyed by the Intercontinental Railway Commission in 1893 will be followed. The line will traverse a rich district, and will be an important factor in the development of a large and fertile section of the republic.

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A GREAT POLAR BEAR STANDING ON EDGE OF ENORMOUS ICE PAN

SO MANY of my friends have asked me how the large polar bears were captured which I brought back from my recent hunting expedition in the arctic regions and presented to the New York Zoological Society that I am tempted to gratify a desire that is perfectly natural

On Saturday, July 30th, at three o clock in the morning in one of the small bays of Ellesmereland, about the seventy-seventh parallel, we sighted a large bear on the ice, a mile or two ahead He stood on the very edge of an enormous pan of ice which extended some two miles back to the shore The lofty mountains of the mainland, furrowed with enormous glaciers, made a beautiful background, and the cold midnight sun, together with the arctic calm, completed a picture that any man would remember to his dying day

The bear stood with his long neck thrust well forward, trying to get our scent Probably he never had seen man before We headed almost straight for him, and when the ship hit the ice a hundred yards to his left, he took to the water like a duck

One of the most remarkable things about a polar bear is his cleverness in diving from a pan ice The most difficult dive for an expert swimmer to make is from something almost at a level with the water The bear makes a more beautiful dive than I have ever seen made by a human swimmer and when he glides into the water, he leaves hardly a ripple behind him They cannot stay under water very long however as we found when pursuing them with the launches

We quickly decided to take that bear alive and after cutting him off from the ice we lowered our launch and started in pursuit Although these bears are able to stay in the water for hours, they are not very fast swimmers; and we very easily overtook our quarry When we ran close up to him he turned to fight, and then we threw a rope lasso over his head took a turn on a cleat and started to tow him to the ship His struggles the hands on deck they were compelled to hold the animal very tightly to keep him from climbing into the launch Presently it seemed to me that the bear was choking, and I ordered the rope loosened at once Too late! His eyes were glassy and he was stone dead

This unfortunate experience taught me something however in the art of catching large bears, and I decided to use different tactics the next time At the same time we discovered that the cages bought from an animal dealer in New York were too small the dealer evidently thinking we intended to catch cubs whereas in reality we were expecting to capture bears weighing from 900 to 1 100 pounds The first mistake we made was in getting the rope squarely around the neck of the animal, so I decided that the next bear we roped I would leave the noose slack until we had gotten his forelegs through it when we could hoist him on board and lower him into the hold without any danger of choking him

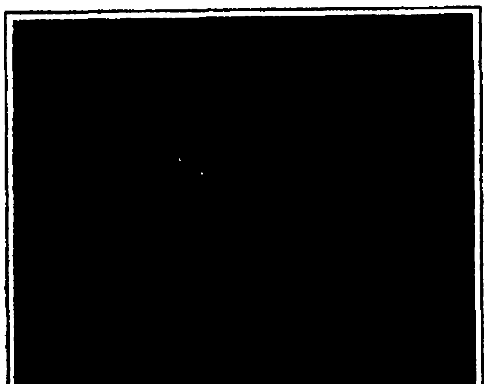
On Thursday, August 4th, we sighted a large bear that the Eskimos took to be a female but which proved to be the large male bear now in the Zoological Park swimming among the small broken pans We lowered the launch and started after him We had considerable difficulty in getting close to him, as he would gain on us very rapidly whenever he crossed over a pan which we were compelled to go around Finally however we succeeded in cutting him off by running between him and the pan for which he was making Just then a very laughable thing happened Capt Bartlett who was steering the launch was sitting on one side at the wheel When the bear saw that he was cut off from the pan he dove and we thought he would come up at the other side of the boat This, however was not in his mind and he came up directly alongside and smashed the boat a terrible blow just about a foot under Capt Bartlett Bartlett gave one wild jump across the boat not even taking time to change his sitting position and is not a very pleasant position to be in At this time the bear could very easily have gotten into the launch!

Finally however we succeeded in slacking away the rope got the engine going astern and gradually started to drag the animal into the water It was a wonderful sight to see this enormous brute with a strong rope just behind his fore shoulders He would rear on his hind legs bite at the rope and jump up and down but the good old Standard motor in the launch did not go back on us and we steadily and surely dragged him toward the edge Finally seeing that the inevitable was coming with a vicious growl he plunged into the water and started for the launch

We did not have much difficulty in keeping him out except when we were turning the launch around and getting it going ahead toward the ship half a mile distant The way he churned the water and twisted and surged was really thrilling but he had left the ice pans forever

We signalled the ship to move into open water as we needed plenty of sea room in which to handle our bear having had all the experience we wanted in the broken ice

After we had gotten some 200 or 300 yards away from the pan ice the big brute succeeded in getting out of the rope and I was compelled to rope him again This time he would not keep his head high enough out of the water to enable me to get the rope over him so we were compelled to run up close and hang the noose on the end of the boat hook By dropping the noose over his head and carefull allowing it to stay slack until he had gotten one or both legs through we at last succeeded in getting him fast once more and started to the ship but not however before he had made one or two unsuccessful attempts to climb into the launch The placing of the noose over his head with the boat hook had its



STRUGGLE OF THE BEAR IN RESISTING TOWING

FINALLY THE ROPE HELD

THE BEAR REPEATEDLY THREW OFF THE LASSO

Photographs copyright 1910 by Paul J Rainey

were something terrific, and in a moment he had thrown the rope off his neck and was free. Recoiling our rope, we threw it and caught him again, and again he fought his way out of the noose to freedom This was repeated many times. He rarely stayed in the rope for more than three or four minutes at a time, as the noose would slip over his small head very easily, when we would be compelled to go back and start all over again.

Finally, however, the rope held, and we succeeded in getting the bear to the ship, when our men swung out the large crane or derrick, operated by a powerful steam winch, to hoist him aboard. When we passed the rope to landed very neatly on the seat of the other side

The bear seemed to have an idea of getting into the launch, and we had to punch him away with the boat hook Finally we succeeded in roping him and this time I took good care to leave the rope slack until he had put his forelegs through it, when I took a turn with our end of the rope around a cleat just as the bear was busy climbing out on the ice. In the excitement, we had neglected to reverse the engine, and when he went out on the ice he very nearly took the launch with him To have a 900 or 1,000-pound bear fastened to your launch and dragging you out on the ice, under a full head of steam, disadvantages, and was rather dangerous, because we were compelled to go very close to the bear

We towed him to the ship swung out the crane, fastened the hook onto the rope and in the twinkling of an eye Mr Green the mate had hoisted him high into the air and swung him over the ship's deck This caused a wild stampede among the Eskimos who were perfectly familiar with the strength and power of a full grown male polar bear Willing hands were at the swinging tackle of the derrick, however and in another moment we had the roaring, raging monster over the hatch of number one hold. As soon as he had been gently low

ered, all hands made a wild rush for the hatch to have a look at our pet

We found him surprisingly cool, merely sitting on his haunches growling and making the champing noise peculiar to bears when angry The rope was still around him but no weight being on it the noose was quite loose and as soon as he moved around it fell off

The next day to my surprise our captive ate small pieces of bread and meat that were thrown down to him Then the question arose how shall we get him into the cage? We needed some of the coal under the bear to keep the ship trimmed *It was a very serious situation* as the firemen did not show any willingness to go down for the coal At once we set to work to knock our small cages to pieces and build a larger one some ten feet long and six feet broad and high We used the iron bars for the door and the sheet iron for the bottom

After starving our bear for four or five days, we pieces of bread and meat that were thrown down to him fresh water inside the cage and lowered it down to the bear He started directly in but the sailor who was working the trap door let it drop too soon and the bear held it up with his back while he backed out

This episode seemed to make the bear very angry for he jumped up on the top of the cage and found that he could put his head and forepaws over the edge of the hatch and onto the deck!

Again there was a wild stampede of Eskimos sailors and dogs for it looked as if he surely would be up on the deck in an instant In the excitement Michael, the wheelman left the wheel and for a moment everything was in a state bordering on panic

At this point one of the sailors did a very brave thing He ran up and struck the bear heavily over the head with a deck mop whereupon after giving a savage growl the animal went back into the hold It was fortunate that he did so for had he gone overboard in the heavy sea that was running it would have been impossible to have stopped and picked him up, and we would have been compelled to shoot him.

Immediately we hoisted the cage out, and waited another twenty four hours, when it was again lowered with a good supply of walrus meat and fresh water, as before. This was quite enough for "Silver King" (as we named him) and in he went Without taking time to untie the rope that held the trap-door, we cut it; the door fell into place, and our bear was in his cage Again the steam winch was brought into play, and we soon had both cage and bear hoisted on deck

As the crowd of Eskimos and sailors collected around in front of the cage, the bear made terrible lunges at them and every time he lunged at the bars it was impossible for the Eskimos to stand still They simply had to break and run

Everything went well until we struck warm weather, and started washing him off with the deck hose every morning Although he had quieted down, this morning ablution business did not suit him at all, and then it was that he made up his mind to get out The construction of the cage was much too light, and on a dozen different occasions he very nearly succeeded in escaping It was terrifying to see him grab hold of the smooth side of the cage with his teeth and tear out splinters a foot long This we finally overcame by nailing a board over *each hole with large spikes through it*; but "Silver King" was very clever about biting around those spikes and never to my knowledge did he scratch himself

One night during a terrible storm the cage broke loose and as the water was running free of the decks, it looked as if he was surely going overboard The alarm was sounded and the entire crew turned out to help secure the cage After heaving the ship to and slowing her down a bit, they succeeded in getting on the well-deck and making the cage fast Another time while we were at supper a sailor put his head in at the door and with a respectful salute said "Sir the *bear is out!*" *Someone said, very sensibly*, "*Please clo*[se] the door!"

It seemed rather dangerous to go down on the well deck, as it was a very dark night. However, we got some lanterns, and hurrying down to the cage we found that the bear really had his head and shoulders out. With the aid of a stout boat-hook, we succeeded, however, in driving him back in, and soon had the hole boarded up After this we always kept a sailor watching the bear, day and night; and I believe we must have driven several thousand nails into the sides of that cage After our arrival at City Island I always kept my big 401 Winchester handy in case of an emergency

After Dr Hornaday and his men unloaded the bear at City Island an amusing incident happened The police captain of the precinct through which they were going to take the bear, got very much worried for fear he would get out, especially after I explained to him that the 32 calibre revolvers his officers were carrying would only serve to get him well stirred up He asked me if I would loan him a real gun which I was very willing to do, and after he had called in one of his officers, I gave him a long discourse on how to load and fire a 401 Winchester A half hour afterwards, seeing the officer parading up and down the dock with the 401, much to the admiration of several hundred men and boys, I decided to see if he still remembered his instructions I said to him: "Supposing the bear got out, and you wanted to shoot him, how would you go about it?" Pointing to the safety catch on the side, he said: "I would push the jigger over and pull the trigger" As I had purposely not placed any cartridges in the barrel he could not have done any great execution

I ask indulgence of my readers for this somewhat lengthy article on catching my bear I am not an author, and probably never will be one, so I hope they will look upon my article with the greatest indulgence—Reprinted from the New York Zoological Society's Bulletin

The Physics of the Polar Seas

Scientific Aspects of the World's Icy Regions

Almost all our knowledge of the physics of the Arctic Ocean is derived from the observations made by Nansen during the drift of the Fram although something has been contributed by the more recent explorations of Amundsen (1901) and the Duc d'Orleans (1905)

The Arctic basin is the northernmost of the deep depressions which lie north of the Atlantic and are separated from it and each other by submerged mountain chains The first of these ridges extends from Scotland through the Faroe Islands and Iceland to Greenland Its crest is nowhere more than 2 000 feet below the surface The most northerly ridge stretching from Greenland to Spitzbergen has not been completely explored but it is not believed to be more than 2 600 feet below the surface at any point As the sea between Spitzbergen and Norway and Bering Strait is shallow the polar basin has no deep connection with the great oceanic basins It forms what is called a Mediterranean basin i e an isolated deep sea in which the temperature and salinity from surface to bottom differ from those of the open ocean at corresponding depths The deep Arctic basin extends from the Greenland Spitzbergen ridge to and beyond the islands of New Siberia but its eastern limit is not exactly known The shallow sea which covers the submerged part of Siberia is from 310 to 370 miles wide and is rarely more than 330 feet deep New Siberia Franz Josef's Land and other islands rise from this submerged continental slope north of which the sea bottom descends rapidly to the great depths of 10 000 to 12 500 feet recorded by Nansen

At the bottom of the Arctic basin the water is warmer and saltier than that of the adjacent seas of Greenland and Norway The waters of the basin are divided into three strata: A cold and not very salt stratum about 650 feet deep a warm salt stratum extending from the depth of 650 feet to that of 2 600 feet and a cold salt stratum extending from the depth of 2 600 feet to the bottom

This phenomenon is due to a discontinuity in density between the superficial layer which is diluted with river water and the bottom layer so that the warmer water of intermediate density flows in between them from the south Nansen's observations all of which were made at the same place and within a short time show minimum temperatures at depths between 160 and 200 feet and maxima between 1 000 and 1 300 feet below which point the temperature decreases slowly to a second minimum near the bottom The proportion of salt increases rapidly from the surface to a depth of between 650 and 820 feet where it is about 3 51 per cent and then remains nearly constant to the bottom

In the superficial cold stratum the temperature varies from 32 deg to 28 8 deg F while the salinity increases from 3 per cent near the surface to 3 47 per cent at the depth of 650 feet This stratum is composed of fresh water derived chiefly from Siberian rivers mixed with sea water coming from the south The precipitation in the Arctic itself is comparatively insignificant Hence the polar sea presents very favorable conditions for the formation of ice which increases the salinity and density of the water immediately beneath the ice and this sets up a rather active vertical circulation within the limits of the cold superficial stratum especially near the coast The hummocks formed by ice drifting together often rise 20 feet above the water surface, which corresponds to a submerged depth of 160 feet, unless they are broader below than above Some solitary blocks are certainly deeper than this The water in contact with the ice is cooled to the freezing point corresponding to its salinity These conditions indicate a minimum temperature of 28 6 deg F at a depth of 200 feet which is approximately the case The calculated and observed temperatures agree exactly however only to a depth of about 66 feet As the depth increases beyond 200 feet the temperature rapidly increases to 32 deg F at a depth of 590 to 660 feet The isothermal surface of 32 deg F is the boundary between the superficial cold stratum and the intermediate warm stratum

Annual variations in temperature and salinity are caused by freezing and thawing In open channels between the ice floes in summer Nansen observed a stratum sometimes 10 feet deep of nearly fresh water having a temperature of 32 deg F or higher distinctly separated from the colder and saltier water beneath Often this surface of separation was marked by fringes and long horizontal needles of ice or even by a continuous sheet of ice in narrow channels This layer of fresh water disappears in autumn

As the ice drifts across the polar basin it increases in thickness each year because much more ice is formed in winter than is melted in summer As the "Fram" drifted westward, the salinity of the surface water increased and its temperature (equal to the freezing point corresponding to the salinity) diminished

The superficial cold stratum is deepest toward the east as it is derived chiefly from Siberian rivers Nansen found its depth 660 feet north of New Siberia but only 560 feet in its eastern part

The intermediate warm and salt stratum is characterized by a temperature above 32 deg F and a salinity exceeding 3 47 per cent It is evidently derived from the deeper portions of the Gulf Stream which, deflected by the subaqueous plateau between Spitsbergen and Norway skirt this plateau and the east coast of Spitzbergen near which they rise over the Greenland Spitsbergen ridge, and flow into the Arctic basin Here they are turned to the east by the earth's rotation and flow along the edge of the submerged base of Siberia

As the Gulf Stream water is confined between two cold strata it becomes colder as it advances eastward It shows a maximum temperature of 33 8 deg F at a depth of 1 050 feet, and a maximum of 32 6 deg F at a depth of 1 475 feet, north of New Siberia At the same time the thickness of the stratum warmer than 32 deg F gradually diminishes The lower isothermal surface of 32 deg F is found at depths of 2 950 feet at Spitsbergen and 2 625 feet near New Siberia

The cold stratum below shows a uniform salinity of 3 51 per cent, while its temperature diminishes from the lower isothermal of 32 deg F to a minimum of 30 6 deg F near the bottom A small increase below this point is due in Nansen's opinion to the internal heat of the earth At a depth greater than 3,300 feet the temperature increases eastwardly, in which direction the temperature of the intermediate warm stratum diminishes Hence Nansen conjectured that these two strata were composed of the same Gulf Stream water which had become cooled during a descending spiral course round the pole But as this water is protected from radiation by the Arctic water above, and contact with the latter cannot cool it to the observed bottom temperature Amundsen's observations in Barents Sea suggest a better explanation The superficial waters of the Gulf Stream enter this sea where by cooling and forming ice in winter along its shores, they yield the cold and very salt bottom water of the central depression There is no deep channel by which this cold water can enter the Arctic basin but the same action probably takes place north of Nova Zembla and Franz Josef's Land and whence the cold water can flow into the polar basin

This description of the three strata of the Arctic ocean is condensed from an article in *La Nature* by Th Hesselberg who gives the information summarised below

The distribution of density can be deduced from the observed distribution of temperature and salinity In the Eastern Hemisphere the surfaces of uniform density slope downward toward the east, most steeply near the surface but very distinctly throughout the upper cold stratum, producing an eastward current at the bottom of this stratum and a westward current at the surface In general the forces due to differences of density conspire with the action of the prevailing winds on the rough ice to produce a current flowing over and on both sides of the pole from Bering Strait to the passage between Greenland and Europe, through which the waters of both the Siberian and the Canadian rivers escape from the Arctic basin The ice closely follows these lines and consequently appears to drift eastwardly in the Western and westwardly in the Eastern Hemisphere but the water immediately beneath the ice, more strongly influenced by the earth's rotation exhibits a tendency toward a circulation from west to east around the pole

The drift of the ice across the polar basin usually occupies three or four years Hence the appearance of the ice varies greatly with the locality It is thin and smooth near the Siberian coast but becomes thick and rough as it approaches Greenland The ice is continually subjected to lateral pressure due to winds and currents, which produces undulations and ridges It is very much distorted along the north coast of Greenland against which it is forced by the current The expansion of ice in cooling produces enormous pressure in severe winters, and piles the ice into great hummocks These, however, are small in comparison with the icebergs, detached from the land ice of Greenland, which drift southward with the polar current. Some icebergs rise more than 300 feet above the water surface, and probably extend to depths of 1,300 to 1,600 feet They are less compact than sea ice, as they consist entirely of compressed snow Icebergs have been encountered in latitudes less than 40 degrees near the American coast, but they are rarely seen south of the Faroe Islands off the cast of Norway

Although the Antarctic region, occupied by a large continent surrounded by water presents conditions precisely opposite to those of the Arctic basin, the two polar seas have some phenomena in common The Antarctic is still very imperfectly known

The melting of the great masses of ice detached from the Antarctic continent produces a superficial cold stratum of small salinity in the southern parts of the great oceans. The "Gauss" encountered, at 65.5 deg. S lat., a stratum 2,460 feet deep, having temperatures below 32 deg F and salinities increasing from 3.30 per cent at the surface to 3.46 per cent at its base. A minimum temperature of 28.6 deg. F was observed at

a depth of 300 feet. This is three times the depth of the Arctic minimum. The difference is due to the vast mass of the Antarctic icebergs in comparison with the Arctic hummocks

Below this cold stratum to a depth of about 6,500 feet, extends a stratum of water warmer than 38 deg F having a uniform salinity of 3 46 per cent. The same salinity is found at still greater depths, but the tem perature gradually diminishes to 31 3 deg F

We find here, then, a warm stratum between two cold strata, as in the Arctic The upper cold stratum is evidently moving northward, while the warmer but denser intermediate stratum consists of water flowing southward from warmer regions The force deduced from the distribution of salinity and density at the sur face is directed northward but the prevailing winds aided by the effect of the earth s rotation deflect the surface current toward the west This current is finally merged in the eastward current which marks the limit of the Antarctic circulation, at about 50 deg S lat The density of the surface water diminishes in going either northward or southward from this line

The Antarctic ice is partly marine and partly terres trial Some of the colossal icebergs are composed chiefly of blue ice formed along the shore Antarctic icebergs are seldom encountered north of latitude 45, but in 1894 the remnants of one were seen in 26½ deg S lat

Our knowledge of the polar seas will almost certainly be improved in a few years A ship drifting with the ice is in the best possible condition for observing the physics of the sea The expedition headed by Roald Amundsen will start from Bering Strait in the autumn of 1911 equipped with the most improved oceanographic apparatus The plan is to cross the Arctic basin as near the pole as possible Antarctic expeditions are also projected

Characteristic Features of Rocky Deserts

Relation of Protective Crust to Ravine Formation

By Dr H Burmester

In every rocky desert are found two distinctive fea tures which form characteristic phenomena of the wide, barren landscape beaten upon by the fierce sun of the sub-tropics: *the so-called tropic protective crust and the intricately winding dry valleys with smooth steep sides known as wadis*

These phenomena have hitherto been regarded as separate and dissociated in cause but recent investiga tions have clearly demonstrated their close connection *and interdependence*

The term "tropic protective crust' is used to designate the thin hard coating found upon all desert rocks This coating due to the intense dry heat consists of a layer of iron and manganese oxide It may be distinguished from the rock itself by scratching with a sharp instru ment.

According to the investigations of Mr J Walther a yellow color shows a newly formed crust containing a hydrated iron oxide a red color shows an older crust which has been changed into iron oxide by loss of water and a gray tint shows the presence of manganese oxide

The colors *of the crust vary between deep black clear* gray and all shades of brown which generally shows the presence of silicic acid the darker the stone the richer being the crust in this acid

The second marked phenomenon of these deserts are the ravines cut deep in the horizontal plateaus inclosed *by lofty unscalable walls, and often ending in a steep* blind wall after long extents, measured by journeys of hours or even days

The desert east of the Nile valley beginning near Cairo is a characteristic rocky desert and affords an ad mirable as well as accessible field of observation

I INVESTIGATION OF EFFECT OF PROTECTIVE CRUST ON INTENSITY OF EROSION

In the desert a distinct difference is to be noted be tween stone exposed to direct sun and that which re ceives little or no sunshine

The first is covered with a crust which is harder than the mother stone and is severely eroded on the surface, to which fact is due the name tropic protective crust

This crust or rind is formed wherever direct sun rays fall but also creeps into tiny superficial cracks into which no rays penetrate It would thus seem to be due to the heating of the stone which favors a chemical combina tion of the stone with the iron and manganese salts of the atmosphere

Those portions of the stone lying in shadow on the other hand are not protected by a crust against super ficial erosion Hence the moisture of the night dew or an occasional rain remains longer and chemical erosion proceeds unhindered

Erosion therefore begins in the shadowed part form ing tiny cracks or projections which gradually increase inward until a cavity is formed in the side or top or the projecting portion eaten away from beneath falls of its own weight

This is called erosion from within outwards When a large piece of rock forming such a projection breaks off a protective crust is at once formed on the exposed sur face of the breach. The fallen block lying on the ground shows the protective crust on every side, but betrays inner cavities which have eroded outward so as to break through the crust, in which case the crust extends in patches from the roof of the cavity

The pendent parts shadow the bottom of the cavities formed by them and therefore accelerate the erosion But these fragments and projections owe their existence to the protective crust since this preserves them from too rapid decay

Often indeed the mother stone is entirely eroded, and only the harder crust still hangs to the rock as the roof or sidewall of a cavity

Thus we see that the term "protective' crust is accurate only in that the stone immediately underlying it is pro tected. On the contrary, the crust favors the shade erosion which is the dominating factor in the desert, since through its greater hardness and durability it allows such shadow-making portions of the rock as the roofs or walls of caves to stand longer than they otherwise would.

Since the crust favors the dominant cause concerned in the characteristic rock forms of the desert, by logical deduction it must be a significant factor in the formation of the wadis.

It is not, however, here implied that the crust is a necessary feature of erosion, since crusted and non-eroded rocks are found.

In order to discover whether there was a "weather side" in the desert I examined Egyptian architecture

In the desert itself there are too many factors con *cerned for a definite result to be reached The direction* of the wind and the hardness of the stone are determin ing factors, and moreover it is difficult to find a block of an undoubtedly synchronous breach and yet of a dif ferent orientation

But it is a well known fact that the stones employed *in Egyptian buildings show crusts after 6 000 years*

One of the best known examples of this is the dam dis covered by Schweinfurth in the Wadi Geraui at Heluan The blocks used there which have an eastern exposure are only slightly attacked on top and show a marked browness yet a distinct cavity is eroded in the soft *gypsum of every stone*

For our purpose, however the pyramids offer the best example being exposed to every point of the compass Of the pyramids at Ghiseh only the Chefren still shows a portion of the original covering near the summit The others show only eroded blocks the time of whose ex posure is undiscoverable

All four sides of the Chepen pyramid have an equally brown tint showing an equal amount of erosion The vertical summer sun therefore has strength enough to develop the crust even on the north side

This facilitates the study of the wadis since in in *vestigating the crust erosion* the orientation of the rocks may be disregarded without its becoming a serious source of error

If we look at the Sphinx we observe that on the back of the head there is a strongly marked crust and obvious erosion has begun while on the eastward looking face there is little crust and little erosion It seems to re main true that where there is little crust there is little erosion

A special form of the crust is here referred to in which on normal brown crusted rock a slag like applied crust appears in spots This is black and always raised in relief If such a stone is cut in sections there is usu ally found lying under these accretions darker stone containing lumps and hollows or else arranged in layers The hardness tests show it to consist of horn stone injections in chalk which explains the dark color since this gains in darkness as it gains in silicic acid It is not unusual for horn tone to be found in localities where fossilized wood is often found In any case we see that harder stone raised in relief lies opposite crust covered chalk

When the chalk weathers its protective crust does not completely resist the outer erosion but renews itself con stantly much like the human skin without showing definite flaking

In this process of renewal it takes material from the mother stone and occasions therefore a steady erosion from without inward

This erosion, which is naturally very slow proceeds side by side with the much more rapid and important shadow erosion

The crust does not always work continuously into the rock There are cases in which the crust breaks loose from the rock in layers—the process of desquamation In such instances the action is ascribed to solutions of salt which have filtered in and then crystallized

WADIS.

The extensive course of all wadis suggests water as the creative agent The question is whether the quantity of water now available is sufficient to have caused them or whether a greater precipitation formerly existed

For the Sinai desert a *pluvial period* seems indicated Hume concludes from marked boulder and pebble de posits that great snow fields existed in former ages He considers it certain for Sinai that now in the pebble de posits of the wadi mouths the denudation exceeds the de posit, and that therefore smaller streams now dig their beds in the pebble deposits washed down by former mighty floods

Direct conclusions as to the Nile valley cannot be drawn from this, but close observation of wadi formation gives various indications that water erosion has had a share in modeling the relief of the desert and that to a *greater extent formerly than now*

Take the Wadi Hof for example It is at once obvi ous that we find ourselves in a valley where water has been active The ground consists of rounded grains of sand If there are contiguous walls we find definite water erosion grooves, with clearly defined wave marks Here we find white eroded channels Yonder we find heaped up piles of rubbish

Now let us direct our gaze to a bank of hard chalk over which erosive masses of water have undoubtedly plowed *when some rare rainfall has sent down its* revivifying floods On this bank we find at spots where the water must flow with slight force light traces of crust while wherever the water has dry furrows with violent deluges not the slightest remnant of the brown crust remains

Thus we see that in many places the water has gained the victory in others the crust has won the day

In order to study better this conflict between crust and water I investigated the chalk banks in the branch wadis leading off from the main wadi since there in all prob ability the crust action would be greater because of the smaller quantities of water

This conjecture was verified for without exception the ground of the branch wadis showed wherever hard chalk banks were present dark crust above earlier erosion marks

In the foregoing I have sought to present a series of erosion phenomena which give an impression that the condition of the desert valleys of the localities consid ered cannot have been caused by such quantities of water as exist at present

The conflict between the water and the crust gave us the clue and showed how in the branch wadis the crust formation had the upper hand while only in the main *ravines could sufficient amounts of water collect to ef fectually oppose the crust formation*

This struggle was active when mighty floods still rushed through the valleys but slowly the waters dimin ished and the crust won the upper hand

The eroded chalk banks show positively that to-day *the crust action is greater in extent than water erosion* for the bed worn by the rain water occupies only a small part of the whole width of the wadi Moreover those parts of the broken stone coated with the brown crust are not partially washed away again as we saw them in the main wadis

If we observe upon a flat surface the formation of a wadi we are struck by the long crooked strips of vege tation which lead to small depressions and mark the course of the wadi It is in these channels that the water runs when it rains forming pools and occasioning the growth of vegetation

The roots of these plants preserve the moisture longer and therefore give rise to more rapid erosion in their neighborhood than in dry localities and thus assist the destructive action of chemical agencies later At some point a projection is formed cavities begin to be en larged and we have the commencement of a wadi

The essential thing is in my opinion the *co operative action* of vegetation and water which loosens or disin tegrates long strips of the desert and makes them more susceptible to subterranean erosion later

That water is present in the sub soil of the wadis is proved by the cisterns which are always found in the course of the valleys But their excavation is continued at the present day essentially by crust erosion and the formation of projections

But the apparent conclusion that no valleys of long ex tent can now be formed without kettle shaped cavities is not justified Let us examine more closely the erosion in the wadis We know that huge blocks fall through being hollowed out and help to widen the wadi their fragments forming the rubbish of the sloping sides On the one hand cavities will be formed on the other the valley will be cut back But since in the backward lengthening process of the wadi the stone is prepared for subsequent weathering by the influence of vegetation and subter ranean erosion the progress of the wadi in this direction will be considerably more rapid Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Globus*

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Excavations in the Ruins of Abasside Palace

ARCHÆOLOGICAL work of some interest was carried out by an expedition sent to Turkey from France and headed by M Henry Viollet He made excavations with the per mission of the Turkish government in the ruins of the celebrated Abasside palace at Simara dating from the first half of the ninth century of our era It is a unique specimen of the architecture of this period which is still very obscure The present palace was the residence of the Arab caliphs who had been expelled from Bagdad for a certain period on acount of military seditions The archæologist has now returned to Paris and made a report to the Academy on the subject.

Safety Stops for Steam Engines

Practical Suggestions for Engineers

By W H Wakeman

A SAFETY stop on a steam engine is of as much importance as a safety valve on a steam boiler. In this article most of the safety devices used in connection with the engine governor are illustrated and their action described.

A safety stop for a steam engine is any kind of a device that will stop an engine should the governing

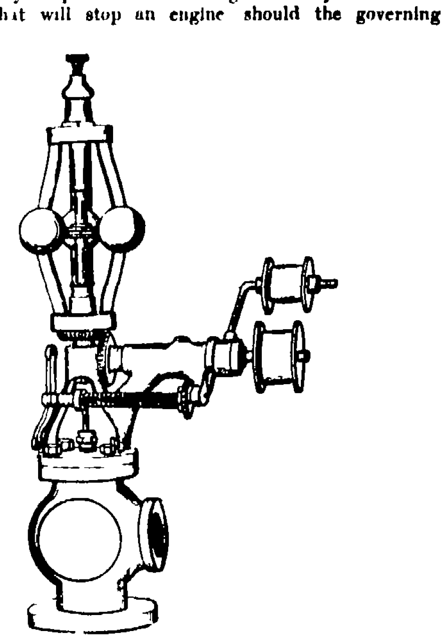


Fig 1

apparatus get out of order, and although some types of stop device will shut down an engine when the load is greater than it can carry under existing conditions, they should also be classed with the safety stop.

Fig 1 shows a simple type of safety stop. An idler travels on the top side of the belt and should the belt break or slip off the idler will fall into a lower position. This disengages the speed pawl releasing the valve which drops, shutting off steam from the engine cylinder. The packing in the stuffing box around the valve stem should be kept in good order, as it is possible to prevent prompt action of this stop should the stuffing box nut be screwed down too hard on unsuitable packing or on packing that has outlived its usefulness.

The governor shown in Fig 2 is located on the engine frame about 4 feet from the cylinder instead of directly over the steam chest. Should the governor belt break or be thrown from the pulley steam would be shut off from the cylinder. The device for opening the steam valves is similar to the Corliss gear. Steam is admitted and cut off automatically from zero to about one half stroke under normal conditions, and if more load is added the flyballs take a lower position and steam follows the piston the entire stroke providing the balls and the center weight do not fall to their lowest possible position.

If the governor belt should break or from any other cause the flyballs should move slower than usual or stop, the center weight will drop as low as possible which will cause the tripping toes on the cutoff mechanism to prevent the steam valves from opening, hence steam is not admitted to the cylinder and the engine will stop. When it is time to shut down a block is inserted, as shown at A. While this allows the center weight to go low enough to give steam to the cylinder during full stroke of the piston it does not allow the safety stop to operate. This makes it possible to handle the engine properly and not allow it to stop on either center. When starting the engine and the throttle valve is wide open, the block A is removed from the governor.

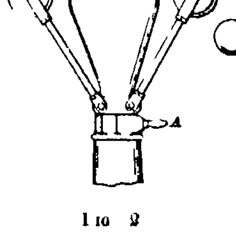


Fig 2

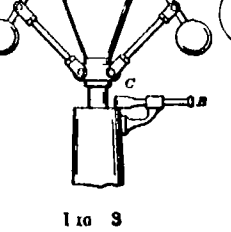


Fig 3

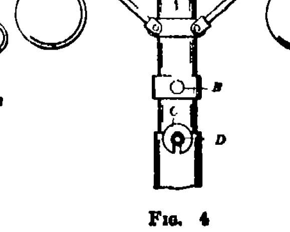


Fig. 4

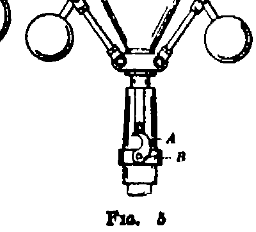


Fig. 5

Another device for blocking a governor is shown in Fig 3, which, to a certain extent, is automatic in operation. It is shown in running position. The sliding block B is held in an out position by a concealed spiral spring. Should the governor belt fail, the flyballs will stop and the center weight will fall to its lowest position. If it is desired to shut the engine down in regular service, close the throttle valve and as the speed slackens, the stop lever B is pushed inward against the spiral spring until it strikes the spindle, and is held there until the weight and collar C rests upon it. When the engine is started and the flyballs gain sufficient speed to raise the center weight, B is liberated, the spring throws it outward and the stop is set automatically.

A homemade device for blocking a governor on a Corliss engine is shown in Fig 4. The sliding sleeve A is in a position for an average load on the engine, but if the throttle valve is closed the projecting pin B falls until

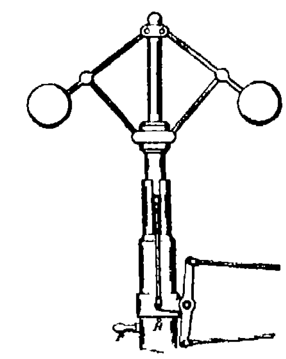


Fig 6

it rests on the thick washer C carried by the stationary pin D. This allows steam to follow the piston full stroke, and enables the engineer to stop the engine in any desired position. When the engine is started again and brought up to regular speed B rises from the washer C which is then removed from the pin D. This permits the collar B to drop low enough to prevent the steam valves from hooking on the catch blocks should the governor belt break.

An automatic device for releasing a governor after it has been blocked is shown in Fig 5. As soon as the fly balls revolve fast enough to raise the center weight the catch piece A turns one half revolution to the right on

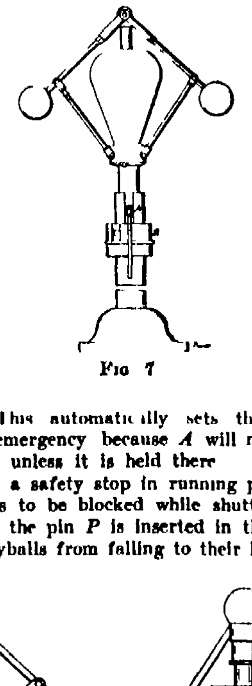


Fig 7

the pin B. This automatically sets the safety stop ready for an emergency because A will not stay in the position shown unless it is held there.

Fig 6 shows a safety stop in running position. When the governor is to be blocked while shutting down and starting again, the pin P is inserted in the hole H and prevents the flyballs from falling to their lowest position. In case the engine should stop with the pin out of the hole H, first close the throttle valve, then lift up the flyballs and put the pin in the hole H. Then unhook the reach rod and rock the wristplate to its extreme travel in both directions so that both steam valves will catch into the catch blocks, and drop the reach-rod hook into place. Steam can then be turned on and the engine started.

The governor shown in Fig 7 is in its running position with a heavy load on the engine. If more load is added the projecting pin A will rest on the movable collar B, causing steam to follow the piston full stroke. If the collar B were moved until the vertical slot C is directly under pin A, and more load is put on the engine, the center weight will fall to its lowest position, causing steam to be shut off from the cylinder.

A governor fitted with a center weight appears to be much more sensitive than if the center weight were omitted, hence it ought to operate a stop motion almost instantly. This form of governor is more sensitive while in full operation than the style shown in Fig. 6, but the former is always operated at a much higher speed, and it will run longer after the belt is removed. The effect of this action on the flyballs is partially offset by the center weight. In either case great care should be taken to have the dashpot, which usually forms a part of such governors, properly adjusted, as otherwise it may hold the flyballs up for a few seconds, when time is very valuable, and thus cause much damage.

This warning may be needed in cases in which such need is least suspected, for the following reason. An engine may nearly always carry a light load, causing the flyballs to move on a high plane, and allowing the center weight to travel through a limited vertical space. Long service under these conditions results in a very easy movement of these parts through their ordinary limits, but when moving below these limits they may not move so easily. This difference would only be noticed when the engine is started, and not then unless the engineer is especially careful to observe the details

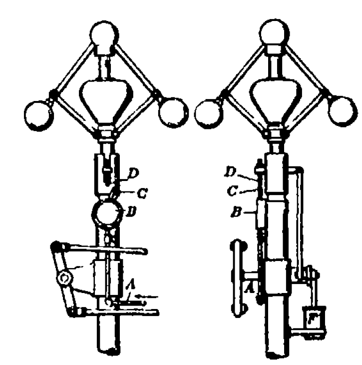


Fig 8

of operation, for the only difference is that the flyballs must be given a higher speed than if there were less friction. Even this may not exceed the highest speed attained under common conditions. After steam is shut off by closing the throttle valve, and the center weight is moving downward, it may show irregular motion, but as this cannot affect any other part, it may not attract attention.

Fig 8 shows two views of a governor equipped with a stop that is automatic in both directions. It is shown in running position. Steam from the bonnet of the throttle valve is carried through the small pipe A into the disk B where it operates on a device similar to the Bourdon spring in a steam gage, which throws C out of a vertical position as shown. Therefore the bolt D cannot rest upon it if the center weight is falling to its lowest position should the governor belt break or come off the pulley. Consequently the stop operates and steam is shut off from the cylinder.

When steam is shut off by closing the throttle valve, pressure falls in the pipe A which is piped to the steam chest or to the throttle valve under the disk; hence, the spring inside of B carries C into an upright position just in time for D to rest upon it. When the throttle valve is opened again pressure begins to rise in the pipe A, but it is not sufficient to throw the lever C over until D is lifted from it by the action of the flyballs, thus requiring no attention from the engineer. F is a dashpot which prevents the center weight from moving too rapidly.

The small pipe A carries pressure to B when the throttle valve is open, but when closed, pressure is shut off from the stop.

A peculiar governor is illustrated in Fig. 9. Centrifugal force, caused by high speed, throws the governor

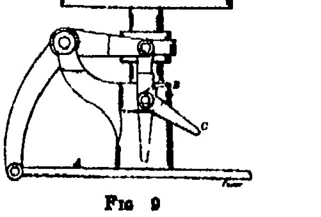


Fig 9

* Reprinted from *Power and the Engineer*

balls outward, and the bell cranks, to which they are fastened, raise the sliding sleeve which operates the long bell crank pivoted at the left-hand side of the governor This gives motion to the horizontal rod *A*, and as it is connected to the tripping devices on the valve gear, it gives a long or a short point of cutoff according to the load carried. The cam *C* is shown in mid-position When the engine is about to be shut down the long arm *C* of this cam is raised to a horizontal position by hand hence the short arm *B* stands vertically and receives the projecting part of the governor When the engine is started again the centrifugal force throws the fly balls outward, and the cam, being liberated, drops to the position shown by the dotted lines.

Every engine stop ought to be given a practical test at frequent intervals (say once each week), to prove that it is in working order For illustration take a Corliss engine with a flyball governor Close the throttle valve until there is just enough steam admitted to maintain full speed Suddenly force the flyballs down to their lowest position and keep them there for a few seconds by holding a convenient part of the governor The engine will run faster for two or three revolutions,

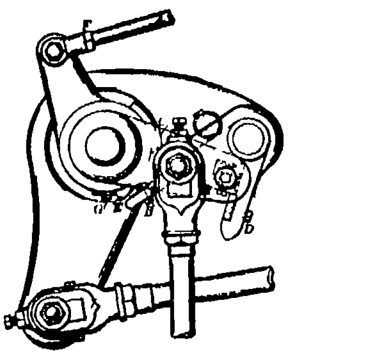
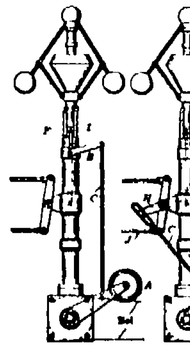


Fig 10

and then gradually stop, provided the adjustments are properly made If not, steam may be shut off from one end of the cylinder, and admitted to the other but this will not give excessive speed If it is not shut off at both ends, make an adjustment that will give the desired result, but do not change the comparative point of cut off, for if they are even they should not be changed, and if the condition of the valve gear in this respect is not known, an intelligent change cannot be made. It is usually possible to set the stop motion without changing the point of cutoff but on the other hand there are ways whereby both can be changed together, and it is plain that these ought to be avoided

Fig 10 illustrates this point and shows the gear for opening and closing a Corliss steam valve The reach rod *A* is adjusted so that when *B* is carried upward by the lifting arm, it will strike the knock off cam *C* and the latch *D* will be unhooked and the dashpot will close the valve If the flyballs of the governor of this engine should fall to a lower plane than at present, the reach rod *A* would be carried to the left and the safety cam *B* would move toward the right hand striking *B* and preventing *D* from hooking on Consequently the valve would not open and no steam could pass into the cylinder It is possible for the valve gear to wear until *I*



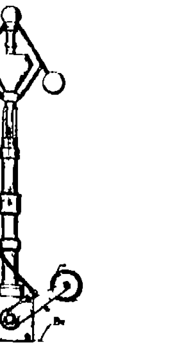


Fig 11 Fig. 12

is no longer in proper position to prevent the valve from opening A careless or thoughtless engineer will loosen the jam nut *F* and lengthen the reach rod until *E* will perform the duty for which it was designed This action causes *C* to be moved from its proper position until it no longer disengages *D* at the right moment, resulting in an uneven cutoff for the engine, assuming that it was even before The correct way is to let *F* remain as it is, and loosen nut *G* and slide *E* into proper adjustment and then screw *G* tightly down upon it

An automatic stop which needs no attention from the engineer when starting or stopping his engine is shown in Fig 11 The pulley *A* rides on the governor belt The bell-crank lever *B* is kept in the position shown by means of the long vertical rod *C* as long as the governor belt remains in place The flyballs and center weight are in position to give the longest point of cut off to the steam valves, as the projecting pin *D* rests upon *B* When the load is reduced, *D* rises, but *B* remains in position If the governor belt breaks, *A* falls, *B* is also lowered and *E* is carried toward the right, therefore *D* goes lower than shown, and steam is shut off because the steam valves do not hook on and the engine stops. An important feature of this device is that if an overload is put upon the engine it will not be shut down. On the other hand, if the governor ceases to revolve for lack of lubrication or any other cause, and the belt remains on the pulleys, steam will be admitted full stroke to the cylinder, causing excessive increase of speed.

Another stop is shown in Fig 19 The governor is

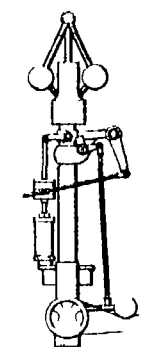


Fig 13

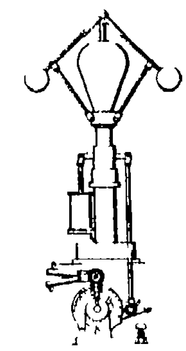


Fig 14

shown with a medium load on the engine The pulley *F* rides on the belt and during ordinary service this pulley does not change its position, consequently the slotted rod *G* is practically stationary If more load is added the center weight is lowered also the right hand end of the lever *H* the opposite end of which moves upward in the slot The lower reach rod *J* moves as indicated by the arrow If the load becomes lighter the centerweight rises and the upper reach rod is carried toward the left, shortening the cutoff The same action takes place when the governor belt breaks, because *F* falls, and the slotted rod *G* is drawn down until the end strikes the pin in the bent lever *H* the effect of which is to force the center weight upward shortening the point of cutoff until it is reduced to zero and the engine stops The collar *L* must be set high enough to allow the center weight to rise as described but no higher As the flyballs rise to operate the stop motion the pulley F and its connecting levers must be heavy

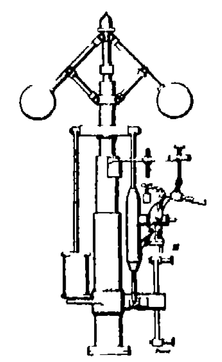


Fig 15

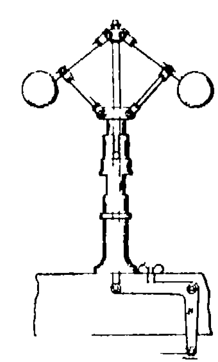


Fig 16

enough to overbalance the center weight, flyballs, etc With this gear the knock-off cams are utilized for safety cams, but only one set is required to both operations

Fig 13 represents another stop depending on an idler for its operation As long as the belt supports this idler the engine cannot be shut down by an overload but when the belt fails the cam *A* is reversed, and is no longer in a position to support the center weight of the governor, consequently when it falls as low as possible, the valves remain closed and the engine stops This device acts quickly because no load is put upon the idler and all of the mechanism connected to the idler tends to carry it downward when the belt breaks

A flyball and center weight governor attached to an ingenious device which operates the cutoff mechanism also the stop is shown in Fig 14 The main parts of this device consists of two disks designated as rear and front, both of which are hung at the center The rear disk *A* is attached directly to the governor by a vertical rod The front disk *B* operates the two reach rods Under normal conditions these disks move together and transmit the motion of the governor to the cutoff mechanism

The flyballs are shown in position for a medium load

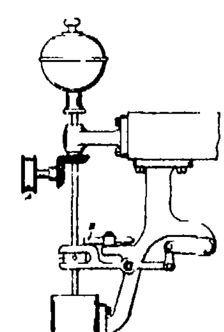


Fig 17

on the engine. If the load is reduced the balls and center weight move upward, rotating the disks from right to left. This demonstrates that if *C* and *D* are carried to the left the cutoff is shortened, therefore if they are carried far enough the steam valves will not open Increasing the load causes the center weight to fall, carrying *A* downward until the pawl *E* rests on the adjustable screw *F*, causing *E* to release the front disk which is quickly thrown to the left by a strong coil spring This action rolls the cutoff cams until they prevent the steam valves from opening But one set of cams is used to designate the point of cutoff in regular service, and to prevent the valves from opening in case of accident to the governor, without raising the center weight

To prevent the stop motion from operating when the engine is shut down under normal conditions, a pin is inserted into both disks, thus locking them together When the engine is started again this pin is thrown out automatically thus making it impossible for the engineer to leave it in place, and render the stop useless

A more complicated form of stop is shown in Fig 15 The rod *A* corresponds to the ordinary side rod on a governor, except that its length is variable and to shorten this length is the sole object of the device because this section throws the ordinary reach rods to their extreme position and steam cannot be admitted to the cylinder The enlarged part of the rod *B* is hollow and fitted with a strong spiral spring which tends to shorten the rod but the pin *C* extends into this hollow part and prevents the operation of this spring

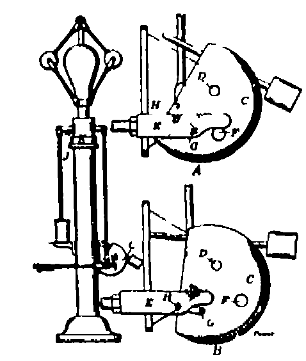


Fig 18

Suppose that the valve gear is deranged and the engine starts to "run away The flyballs rise carrying the spring supported lever *D* upward until it strikes the stationary stop *F* As *D* is depressed by this action *C* is withdrawn from *B* and the inclosed spiral spring draws the reach rod lever upward shortening the point of cutoff to zero (without carrying the flyballs higher) and as steam cannot enter the cylinder the engine stops

During ordinary service the rod *F* slides freely in the plate without interfering with the action of the governor in regulating the engine speed However if the belt runs off the flyballs drop to a lower plane and the movable part of the device is lowered until *F* rests upon *G* thus pulling *D* down as before drawing *C* outward and allowing the concealed spring in *B* to draw the reach rod lever up until the point of cutoff becomes shorter and finally is reduced to zero stopping the engine When preparing to shut down the engine in regular service, the stop is rendered inoperative by adjusting the plug *H* thus enabling the engineer to stop and start at pleas

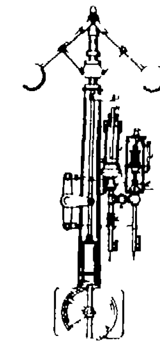


Fig 19

ure When the engine is started again the flyballs rise and liberate *D* which action throws *H* back automatically into the position shown

A very simple device for operating a stop is shown in Fig 16 As the flyballs drop the rod *A* is carried toward the right by means of the bell crank lever *B* and this prevents the steam valves from opening A slot is provided in the frame for the thumb nut *C* allowing it to move freely vertically as long as it remains in the position shown but if it is turned at right angles to this position it cannot pass through the slot While turning the thumb screw prevents the device from operating in case the governor belt breaks it is necessary to do so in order to operate the valves while starting and shutting down the engine If the thumb nut is not set in the running position the device is no longer a safety attachment

Fig 17 illustrates a governor which is set low on the engine frame The pulley *A* is driven from the crank shaft by a belt and bevel gears transmit motion to the vertical shaft, on which is mounted a pair of flyballs inclosed in an iron case *B* If this belt breaks, the flyballs come to rest, and the vertical shaft is drawn upward the revolving collar *C* moving with it, thus turning the side shaft *D* through part of a revolution This action prevents the steam valves from opening

This stop will not operate while the hand lever *E* is

in the position shown, because it prevents C from rising but when given one quarter revolution C is at liberty to rise A dashpot G prevents C from rising and falling rapidly

Another type of stop and its operating mechanism is shown in Fig 18 Two views of the tipping device are shown at A and B A shows the position taken with a light load on the engine The half-circular plate C is carried by a short shaft The reach rod F rests upon the pin I and is held there by gravity also by action of the link The pin G is set into the reach rod and H is a similar pin set into the plate C Therefore the stress upon the rod in the direction of the arrow will hold E more firmly on the pin H

If the governor belt breaks, J is lowered into the slot in the moveable collar K and the action is further illustrated by B The plate C has turned toward the left until the pin H is lower than pin F, causing the link to reverse its position, thus moving E toward the left twice the length of the link, which is sufficient to operate the stop

A stop operated by electricity is shown in Fig 19, used in connection with a Corliss governor, but it is suitable for several other types of valve gear Steam at boiler pressure is admitted to the angle valve A, which is closed under normal conditions When the crank-shaft speed exceeds the limit for which this stop is set, a special governing device closes the electric circuit B and the armature C releases the lever D This act allows steam to open A, when it passes through check valve E into the vertical cylinder F, causing the piston G to rise and the rod H to lift J until the collar K prevents it from going higher, thus raising the flyballs to their highest position, and rolling the knock-off cams on the valve gear so far around that they prevent the steam valves from opening

When D is replaced, A is closed, and by opening the drip L all pressure is released from F, thus allowing the piston G to resume the position shown, when the stop motion is ready for service. Then the throttle valve is closed, the steam valves hooked up, and the engine is ready to start

The Exploitation and Culture of India Rubber Plants

Business Aspects of the Question

The success of India rubber culture or even of the exploitation of wild plants is not always certain It depends upon a great number of conditions which have not received the attention which they deserve The problem is one of great complexity The India rubber plant is not a single species but there are many plants native in various parts of the globe from which India rubber can be obtained and every tropical region has its special indigenous plants Can all of these be exploited or cultivated profitably or should one be selected for cultivation everywhere Would it be better to abandon the collection of wild rubber and to cultivate new indigenous or foreign species? Many African colonists do not hesitate to reply that the cultivation and even the rational exploitation of the native rubber vines should be abandoned and replaced by the cultivation of the Brazilian species *Hevea* and *Manihot Glaziovii* which they regard as superior in many respects to the African rubber tree *Funtumia elastica* (*Kickxia elastica*) In Java and British India the cultivation of the *Ficus elastica* is gradually being replaced by that of the *Hevea* which has been planted largely in the Federated Malay States and the Straits Settlements Mons E de Wildeman the curator of the botanical garden of Brussels, who discusses these questions in *La Nature* approves the extension of the culture of the *Hevea* but not the abandonment of the culture and exploitation of suitable indigenous plants He supports this view with regard to Africa, at least by the following considerations:

Tropical Africa produces a great variety of India rubber plants including vines which contain rubber in their stems, roots or both; herbs which contain rubber in their roots or tubers only and trees from which rubber can be obtained by means of incisions in the bark In all of these three groups we find productive rubber plants which have been exploited by the natives, in some cases long before the period of European colonization No one of these plants can be cultivated everywhere for the different species require different conditions of life Hence the choice of a species must be made carefully and no species foreign to the region even if indigenous to the continent should be planted extensively before preliminary experiments have been made not with a few plants but with several hundreds at least The plants behave very differently according as they are cultivated singly with great care or planted closely in large numbers The dense plantations are subject to diseases and require many precautions

The plant then should be suitable to the region and consequently it is desirable to propagate the native species In Africa in particular certain vines known to be extremely productive should be cultivated

Another important question is that of labor If the cultivation of the *Hevea* is profitable in the Malay States and Straits Settlements it might be thought that it would be equally profitable in Africa where the climatic conditions are very similar In Africa however we do not have the same class of laborers The coolies of Java and Ceylon are unquestionably much more competent than the African negroes with rare exceptions The production of India rubber from the *Hevea* requires not only the comparatively simple work of cultivation but the very delicate operation of tapping or bleeding In Asia this operation is performed with a minute care which cannot be expected from African negroes, unskilled in work of this sort and averse to regular work of any kind The very life of the plantations would be jeopardized by putting them in the hands of unskilled workers. Hence, until the natives have become more civilized it would be better to allow them to treat the indigenous rubber plants as they have done for many years, meanwhile establishing, in suitable places where laborers are abundant and can be watched experimental plantations, which may have a great influence on the economical future of the region

In the Belgian Congo extensive cultivation of the *Hevea* is being earnestly advocated, although no commercial company has yet undertaken this culture on a large scale. The sanguine expectations are based on the few successful results obtained in experimental plantations but the economic value of the cultivation of any particular species of India rubber plant can not be definitely fixed without observations extended over from 3 000 to 5,000 trees. This does not mean that it is necessary to abandon the cultivation of the *Hevea* in Africa and every other region where it is not indigenous Extensive cultivation should be commenced however, with the native vines and the *Funtumia* When favorable results have been obtained from many large plantations of *Hevea* we can judge whether it is necessary or desirable to substitute the Brazilian plant entirely for the native species It appears probable that the native plants will maintain their superiority Every tropical colony and indeed, every country and every natural division of a country should remain its indigenous products

Another important question concerns the method of extracting the latex from which India rubber is obtained We do not yet understand the utility of the latex to the plant Is this liquid which contains various useful substances a waste product of no further use to the plant? Is it a means of defense against enemies or does it contain ingredients which again enter into the life of the plant? There is probably some truth in each of these hypotheses At all events, the removal of the latex always causes a disturbance in the life of the plant, diminishing its vitality and power of resistance to disease In all intensive cultivation, diseases are constantly becoming more virulent and the pathology of plants is becoming a more important science to the agriculturist

Numerous experiments made in the Straits Settlements and the Malay States, appear to prove that the only practical method of exploiting the *Hevea* is by means of the "half herring bone" system of incision deepened daily or every other day In this manner all the bark of the trunk is removed in a time which varies with the skill of the workmen The bark is gradually renewed but a time arrives when only a very small portion of the original bark remains The operation is then recommenced on the new bark which is usually four years old The primitive bark is generally seven years old when the first incisions are made The cultivation of the *Hevea* has not continued long enough to make it certain that this method can be pursued indefinitely without destroying the plantation For this reason it appears more advisable to employ the rather brutal process which is still used by the natives of many tropical regions, and which consists in felling the tree at once It is an error to suppose that this barbarous method necessarily destroys the rubber plantation or forest If the natives are allowed to fell every rubber tree they find the number of productive trees will certainly diminish, but if the trees to be felled are selected with care or even if the natives are given a free hand without being urged to excessive production the young growth will, after a certain number of years, form a productive plantation Rubber vines also should be cut off, instead of being tapped

The idea of extracting rubber from the bark of the *Funtumia* by a mechanical process appears to be due to Prof Warburg of Berlin This method has been abandoned in some districts It has recently been taken up experimentally with excellent results in French Africa. With the *Funtumia* then regulated felling and mechanical extraction of the rubber from the bark appear capable of furnishing a maximum quantity of rubber and also of insuring the maintenance of the plantation by natural growth

We know that India rubber can be obtained by mechanical processes from all three groups of African rubber plants, herbs, vines and the *Funtumia* tree and for tropical Africa in present conditions this method appears preferable to any other

Still another question of very great importance concerns the capital required in the cultivation and exploitation of rubber plants in the Malayan Peninsula A hectare (2½ acres) planted with *Hevea* trees is worth $4,600, even before the plants are old enough to be incised The same land a few years ago was worth only $100 In presence of such fluctuations of value the economic conditions of cultivation are totally changed, and another argument is advanced in favor of the exploitation of native species, which requires much smaller capital Mons Brenier says that this excessive increase in the price of India rubber plantations reacts in favor of the wild rubber of Brazil and Africa It should be noted here that the Brazilian rubber producing States are not only seeking to exploit the natural forests more rationally, but are also encouraging the formation of plantations of the *Hevea* which should succeed on its native soil better than elsewhere.

It is certain that the world has room for extensive plantations of rubber trees and that immense quantities of rubber can be produced and used to advantage; but it is equally certain that a day of overproduction will come sooner or later If all the young plantations now in existence shall in a few years produce as abundantly as the old plantations, overproduction is inevitable and near The constant developments in industrial chemistry will increase the employment of regenerated and inferior rubber, perhaps of substitutes for rubber, and this will naturally lower the price The date of this overproduction does not appear so near when we note that a large proportion of the trees now planted especially in Eastern Asia, are unproductive, owing to errors in cultivation and in selection of plants and soil Mons Brenier proves that the competition which is bound to come will leave in existence only those plantations which have been established in the best cultural and commercial conditions, and have received the greatest care in selection of plants, cultivation collection and preparation of rubber, in the prevention of disease and in the maintenance of a force of competent workmen In a word, the successful companies will be those which treat their trees most scientifically such as the larger companies of the Malayan Peninsula, each of which maintains its private staff of chemists, botanists, mycologists, etc

An attentive examination of the numerous problems presented by the cultivation of rubber plants only serves to show the depth of our ignorance in regard to the history, life and proper cultivation of these plants Every country which is directly interested in the production of rubber should give serious attention to the study of local production and should establish botanical and chemical laboratories, working in harmony with the experimental plantations Holland has long followed this excellent plan and some English colonies have also founded laboratories Within a few years Germany has established experimental plantations and laboratories in several colonies, and schools of research and instruction, devoted especially to rubber culture, have been opened in Berlin This example will probably be followed in England The complex problem of the rubber industry can only be solved by constant harmonious co-operation between men of science and men of practice. The solution will not be obtained in a short time—*La Nature*

What Men Do with Their Dead

To many persons, death is incomprehensible Even civilized men shudder at the sight of the dead face of a man whose mental powers have won their admiration Death inspires still deeper awe in primitive peoples, who regard it as the work of supernatural powers, invoked by sorcery If a beetle hums or a moth flutters about the corpse the insect is believed to harbor the soul that has left the body The methods of disposing of the dead are based on these beliefs These methods will be copiously illustrated at the approaching International Hygiene Exhibition in Dresden The following notes are quoted from *Hygieia* the journal of the exhibition

The dead person may be regarded as a friend or as a foe, and the treatment of the corpse varies accordingly Almost all races, even the most primitive, render some services to the dead, if only for the sake of performing a duty and escaping post mortem vengeance The Tasmanians believe that the souls of the dead migrate to planets hence they deposit corpses in hollow trees This practice suggests the origin of the coffin It is often considered essential for the dead man to rest in his native soil Hence migrating tribes have carried some of the home soil with them in their wanderings, for filling graves.

These are some of the friendly offices to the dead. When the spirit of the deceased is feared as an enemy, the treatment of the body is very different. In many cases it is left lying in the house of death, which is then tightly closed and shunned with superstitious awe. The idea of separating the dead from the living is expressed still more clearly by the practice of fettering the corpse before burial. In this way the possibility of return to life is supposed to be prevented The practice of cremation is partly based on this fear of the dead man's return. The ashes or unconsumed bones are usually inclosed in a suitable vessel. The custom of exposing the corpse to be devoured by wild beasts and birds is still practised by the Parsees. It indicates a high degree of contempt and aversion. The body is rendered quite harmless and the mental powers of the deceased are compelled to seek refuge in the sharers of the feast. The disposal of the dead serves to illustrate the general law that the apparently hygienic precautions of primitive races are founded on fear of demons and sorcerers. This is true, to some extent, of the art of medicine in general.

Shearing Sheep by Machinery

How Frenchmen Have Improved an American Invention

SOME agricultural operations which can be accom plished rapidly and perfectly by machinery are still performed almost everywhere by hand, with very primi tive tools. The machines devised for such work are, in general, employed only in large establishments, as they are too costly for small farmers and are otherwise unsuited to their needs. Some machines, however, are moved from farm to farm, so that they may serve all the farmers of a district. In France, this expedient appears to have been adopted first in the case of distilling apparatus Itinerant threshing machines and sawmills are now common

A similar method has lately been adopted for shearing sheep and the work which formerly occupied weeks can now be accomplished in one day by a portable apparatus Machine tools driven by a crank and flexible transmission, have long been employed for shearing sheep and clipping horses This device requires two men for each animal shorn, one man turn ing the crank while the other applies the shears or the clipper but it expedites the work, clipping a horse in one hour and shearing a sheep in five minutes, and it spares the animal the wounds which are frequently in flicted by hand shears An electric motor can ad vantageously be substituted for the man who turns the crank

A great advance has been made by the introduction of an explosion motor capable of operating several ma chines at once A wagon maker at Gaissy in Cham pagne has constructed a traveling sheep-shearing es

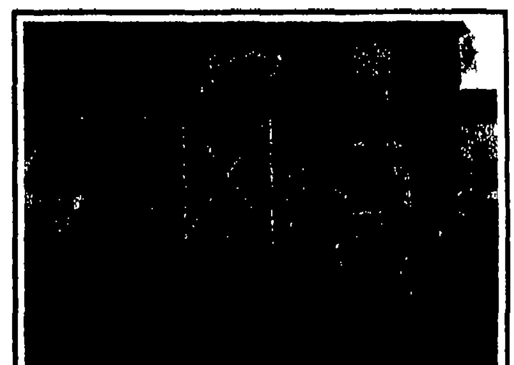


FIG 1—A SHEEP SHEARING CAR

tablishment equipped with 4, 6 or even 10 shearing machines, driven by a single motor The apparatus has been employed with success on the flocks of Champagne and it attracted much attention at a recent agricultural exhibition It is mounted on an ordinary four wheeled platform truck

A small gasoline motor, of 5 horse power, drives a horizontal shaft, to which each of the shearing ma chines is connected by the flexible transmission de scribed below The car is furnished with benches on which the sheep are placed and with a removable canvas roof

The shearing machines are arranged in pairs, to right and left of the driving shaft, to which each machine is connected by an arm composed of three segments joined in such a manner that it can be moved freely in any direction. Two of these segments are tubular and contain an endless cord which passes over a grooved wheel on the driving shaft, and a second grooved wheel, carried by the shearing machine The transmission is illustrated by Fig 2 The tubular segment D and E are suspended from one end of the solid rod B which carries a counterpoise C at its other end The tubes D and E are connected to the rod B to each other and to the shearing machine T by the universal joints F G H When the particular shearing machine shown in the illustration is not in use the weight of the counterpoise C causes the rod B to stand nearly vertical in which position it releases the clutch which connects the grooved wheel P with the driving shaft and allows this wheel to stand idle though the shaft, driven by the belt R may be rotat ing and operating the other machines In order to bring the machine T to the sheep's fleece it is necessary to pull it downward depressing the rod B to a posi

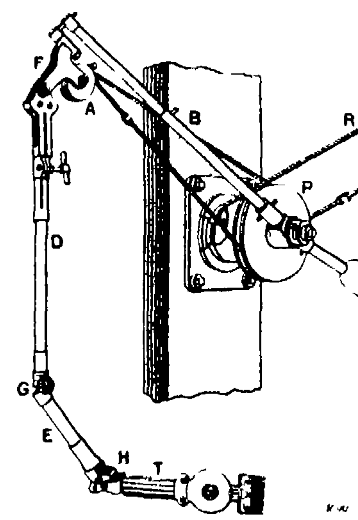


FIG 2—THE FLEXIBLE TRANSMISSION

tion in which it clutches the wheel P to the driving shaft The endless cord passes over two guide wheels I at the first joint F and over two smaller guide wheels at each of the joints G and H

The shearing machine is illustrated by Fig 3 The two parts of the endless cord, after traversing the tubular handle of the implement are guided by two small wheels G H to a large grooved wheel A pin placed eccentrically on the face of this wheel, engages with a fork on one end of a lever the other end of which is attached to the toothed blade P Hence the rotation of the wheel gives a reciprocating motion to the toothed blade which slides over a fixed comb as in an ordinary clipper

The shearing car shown in Fig 1 carries six shear ing machines and a set of machine tools for sharpen ing blades and other purposes As each machine can shear a sheep in 5 minutes 720 sheep can be sheared in a day of 10 hours—*La Nature*

The Interior of the Earth

THE interior of the earth is scarcely more accessible than the stars to direct experimentation and is less known through valid indirect evidence Some information is given by earthquake shocks which though local in origin shake the whole earth By collating the records of seis mographs in various places it has been learned that the velocity of the earthquake wave is 3 or 4 miles per second in the upper strata of the earth and more than 10 miles per second in the central nucleus The earth as a whole may be compared to a great spherical bell which when struck makes only two or three complete vibrations per hour As the note emitted by a piano string depends on its length, thickness and tension, so the note of the earth bell and the velocities of waves in its different parts give some indication of the state of the concentric strata of which the earth is composed

The information thus obtained is very incomplete and scientists have endeavored to fill its voids by means of various plausible hypotheses A review of our present knowledge of the earth recently presented to a French scientific society contains two remarks of especial interest concerning the variations of gravity and pressure in the earth's interior

If a shaft were sunk vertically to the center of the earth and an object, suspended from a spring balance were lowered down the shaft the weight of the object, as indicated by the dial of the balance, would at first in crease, as the descending object approached the deeper and denser strata After passing a certain depth, how ever the weight would begin to diminish, and it would continue to diminish to the center of the earth, where its value would be zero, because the object would there be equally attracted in every direction.

The pressure increases enormously with increasing depth below the earth's surface It must be about 900 000 atmospheres at a depth of 400 miles (1/10 the earth's rad ius), 4,000 000 atmospheres at 2 000 miles (half the ra dius) and more than 100 000 000 atmospheres at the center At such pressures the materials of the earth, though heated above their melting points, are probably quasi solid and as rigid as glass or steel Hence the velocity of propagation of vibrations must exceed the velocity of sound in ordinary solids such as cast iron, in which it is 20 000 feet per second

Directed Wireless Telegraphy

THE Bellini-Tosi system of directed wireless telegraphy is now in practical use on land and sea, according to a letter addressed to *La Nature* by the inventors and has

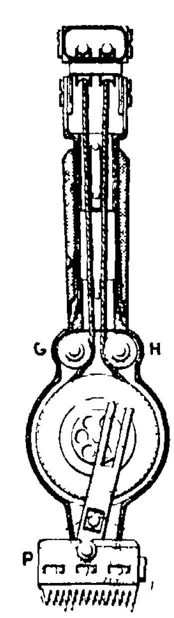


FIG 3—THE SHEARING MACHINE

given entire satisfaction At Boulogne France, the system has been in continuous operation since January 1910 It works perfectly and has rendered great service to navigation The station uses a wave length of 300 meters (984 feet) and a range of 300 kilometers (186 miles) On shipboard a special application of the system is made so that the position of the vessel can be determined in foggy weather by means of the coast wireless stations The position is thus found as accurately as it can be deter mined by the ordinary usual methods in clear weather

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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1859, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.
Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., 361 Broadway, New York.

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An English Water Dynamometer for Absorbing 1 OOO Brake Horse power

By Frank C Perkins

The accompanying illustration shows the construc tion and method of operation of a 21 inch water dynamometer of the Froude type now in service in a testing department of a shop at Worcester Eng land and capable of absorbing 1,000 brake horse-power at 700 revolutions per minute

This machine was designed for the purpose of de termining with absolute accuracy the power de veloped by an engine or motor in an expeditious and practical manner and is capable of regulation so that the power put into it at any speed can be absorbed from the minimum to the maximum capacity of the dynamometer

The dynamometer consists primarily of a turbine or rotator revolving within a casing which is mounted on friction rollers and connected to a water supply so as to enable the casing to run full of water when the machine is in use The rotor is fixed to the shaft which projects on either side of the casing and to which the engine or motor to be tested is coupled Engines or motors of either direction of rotation can thus be proved on the one machine

Each disk face of the rotator is formed with a semi-elliptical annular channel divided into a number of compartments by means of ob iq ıe vanes The corresponding faces of the casing are also formed with similar channels divided in the same way The channels on the rotator and the casing thus form two complete annular channels of elliptical cross section each channel being divided as previously stated into compartments by means of the oblique vanes

The water in each annular channel is rotated con tinuously by the centrifugal force imparted to it by the rotator and it passes from one compartment into the next and so on An extremely high speed of rotation of the water is obtained and the power or energy p t into he dynamometer is by this means converted into heat which passes in the water leaving the machine.

The motion of the water causes the rotator to re-act on the casing and tends to turn it on the friction rollers. This is prevented by means of an extension or arm, working between stops at the end of which are the balance weights and the counterbalance by which is measured the actual power put into the dynamometer

In order to reduce the power absorbed by the dyna mometer when required thin metallic shields are provided which are interposed between the faces of the rotator and the casing, thereby cutting off a por tion of the effective area of the annular channels In h s manner the power may be reduced from the maximum down to about one thirtieth of tl at an ount

The friction rollers supporting the asi g are ad justable, so that the dynamometer shaft may be read ly brought in line with that of the engine or motor under test.

The horse-power absorbed by the dynamometer = brake horse power of engine or motor $\dfrac{W \times N}{K}$

when

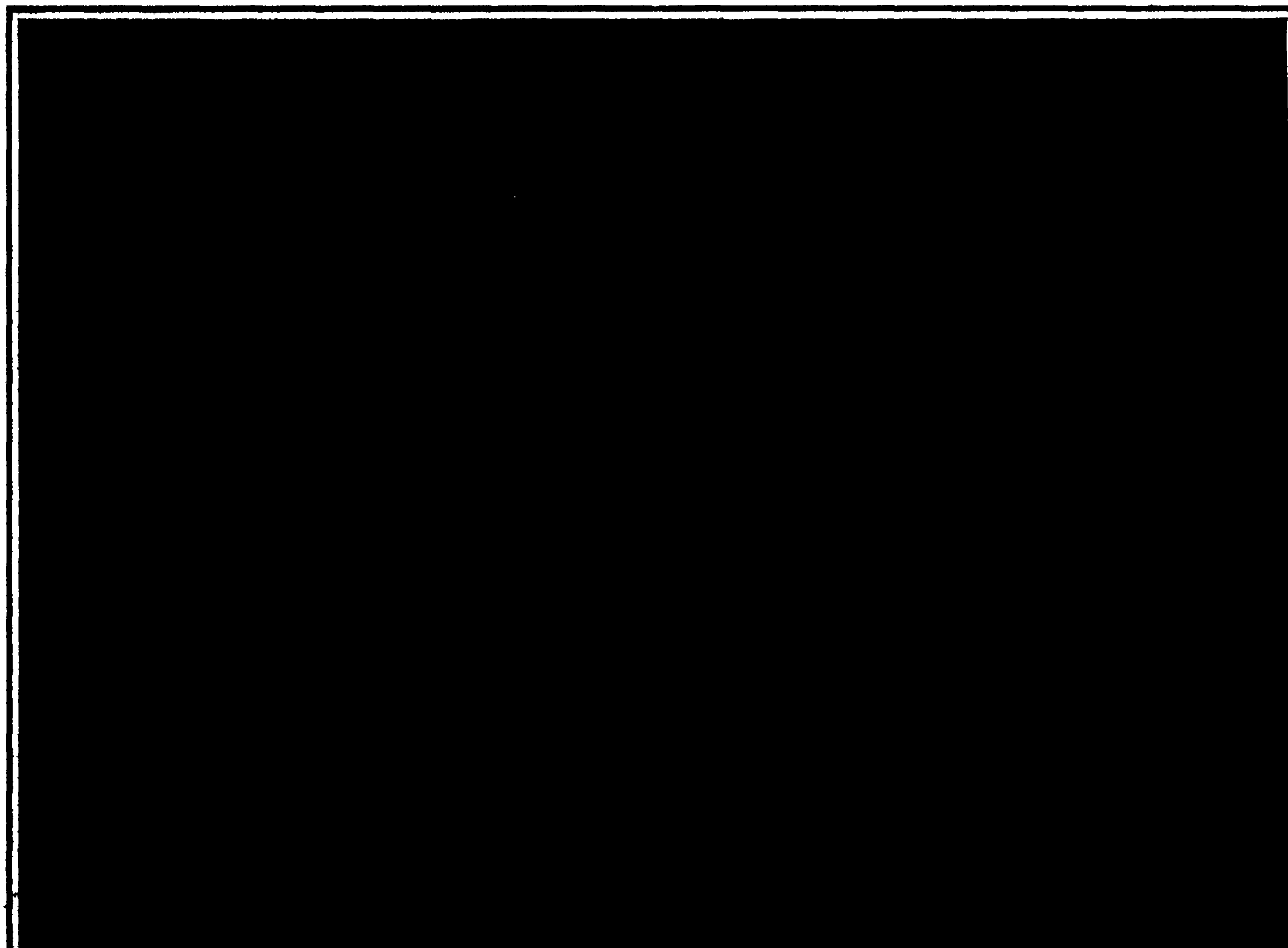
W = The effective weight in po nds at the end of the dyna nometer arm

N = Revol ions per minute

K = The constant for ea h machine and is de-rived from $\dfrac{33\,000}{\pi \times 2L}$ as in the Prony brake formula where L equals the radius or the length of the arm

The quantity of water used = 1 89 gallons per horse-power per hour as can be obtained from the following calculation

$$\text{Gallons per hour} = \frac{\text{H P} \times 33\,000 \times 60}{778 \times 10 \text{ Temp difference between water at inlet and outlet.}}$$



21 INCH FROUDE WATER DYNAMOMETER AT WORCESTER ENGLAND CAPABLE OF ABSORBIN 000 BRAKE HORSE POWER AT 700 REVOLUTIONS PER MINUTE

Handling Passengers on a Rapid Transit Railroad*

Construction of a Rapid Transit Line as Illustrated by the Hudson and Manhattan Railroad

By J Vipond Davies

Passenger transportation has developed the most complex problem which is to-day presented to the engineer for solution The immense increase of population particularly with reference to the concentration in cities has produced new and grave conditions which have to be cared for by a careful study of individual cases as each case requires absolutely new and independent treatment With the steam railroads the problem of handling passenger traffic remains very much as it formerly did except that with the extension of cities into their suburban districts the local traffic has become so much heavier that the distribution of passengers from the terminal destination introduces a new and serious problem The number of persons who desire an all-the-year-round residence in the country districts and who conduct business within the cities is becoming yearly greater and is only made possible by improved transit facilities being provided This condition has also become a considerable factor in increasing the taxable values of suburban real estate and in developing real estate in the suburban districts of the great cities London and New York offer the best illustrations of this condition as in each of these cities there is a small district of limited area in which the bulk of the business is transacted and a huge territory radiating in every direction where the business people have their residences The state line between New York and New Jersey is a fictitious division and eliminating all consideration of the boundary line between these two states there is a district tributary to New York city which has a total population of over 6 500 000 persons In a community of this character the nearer one gets to the center of the city the more dense becomes the traffic the need for increased transit facilities greater and the possibility of movement slower all on account of the great concentration and the interference of cross-streams of travel Every one is familiar with the fact that for reasonably short distances within this zone of density one can reach his destination quite as quickly by walking as by using a surface car As one gets farther from the center of a large city and approaches the country the traffic thins out proportionally with the density of the population and at the same time the possible speed of transportation becomes greater The latest figures available indicate that the total movement of passenger traffic within the metropolitan district of New York aggregates very close to 2 000 000 000 passengers a year on all lines which is equivalent to 308 rides per capita per annum and the movement of passengers within the Borough of Manhattan averages over 400 rides per capita per annum In order to get more rapid service for passenger traffic it has become necessary in New York to move the means of transportation from the surface of the streets where there is interference with every other class of vehicular and pedestrian travel As a city grows to the size which is now known as a city of the first class these conditions arise the necessities become similar and gradually the large cities are forced into doing what New York is doing at the present time viz to install transit lines either above or below the surface so that rapid transit service may be carried on without interference with other transportation and thereby obtain a greater measure of rapidity and safety in the service In the city of London this condition arose many years ago earlier possibly than would be the case in most American cities on account of the narrow streets and the consequent tremendous surface congestion With broad avenues or streets the period of congestion is postponed so that the necessity for transit lines either above or below the surface is not reached at quite as early a period in the growth of a city Our great cities are not willing to develop elevated railroad lines anywhere near their hearts on account of obstruction to light and air the further and serious obstruction to other traffic and what is by no means the least objection the great nuisance of increased noise so detrimental to the nervous systems of people who must hear the roar of the traffic At the same time in many of the American cities elevated railroad lines are deliberately and it seems foolishly installed in the suburban districts purely on the ground of the cheapness with which they can be constructed or in order to obtain what is called rapid transit service at a reasonable cost in districts sparsely populated This has been deliberately done with the present Rapid Transit Subway in the city of New York where in the northern portions of the city the subway emerges onto an elevated structure and runs over long sections of steel viaducts To a considerable extent the same has been done in Philadelphia If any such structures are necessary and are hereafter built, they should be carefully designed and constructed so as to eliminate all noise arising from an exposed light steel structure This may be accomplished without any great addition in first cost and with only slightly increased obstruction upon the surface of the ground

The title which has been adopted in this country for transportation other than on the surface has an unfortunate adaptation as it involves a good deal of service which is by no means rapid transit The service to which these or any lines of public transportation are applied is affected materially first by the density of the population and second by the local conditions At the same time it is readily understood and appreciated that the service is the heaviest at certain hours of the day and lightest at other hours and curiously enough it seems that on most lines the traffic curves correspond very closely that is to say granting a certain total daily service given by any line of railroad whether on the surface on ferries crossing the rivers on an underground or steam railroad line which does a local transportation business within our populous areas the curves of traffic per hour are very similar varying of course according to the total movement per diem These curves reach their summit or peak in the morning hours in the movement toward the heart of the city between 7 and 9 o clock and reach the corresponding peak for the evening outward bound movement between 4 30 and 6 30 o clock The Public Service Commission has rather happily designated these movements as workwards and homewards respectively The morning peak in one direction workwards toward New York reaches its maximum between 8 and 9 o clock 7½ per cent in the direction of heavy flow and in the opposite direction simultaneously 1½ per cent of the entire total traffic in both directions per twenty-four hours while the homeward peak in the evening—the heaviest and controlling movement—reaches its maximum between 5 and 6 o clock, when the outward movement is 10 7 per cent and the simultaneous reverse movement 2½ per cent of the entire total traffic in both directions for the day The movement during the middle of the day is very much less while the movement after midnight is extremely light, and no railroad operates suburban trains at a profit during the wee small hours of the night but only on account of its general obligation to the public

The Hudson and Manhattan Railroad Company was organized as a private enterprise and as an interstate railroad to handle a proposition which is new and unlike any other in New York city or elsewhere As every one is well aware, the steam railroads handling New York traffic terminate for the most part on the west bank of the Hudson River whereas the destination of the passengers is almost entirely within the city of New York Similarly the street railroads have their termini at various points along the Hudson River front and a very large portion of the traffic is carried from points in New Jersey to these termini for ferriage across the Hudson River to New York city The Hudson and Manhattan Railroad differs therefore from the ordinary rapid transit railroad in that it is a terminus in the city of New York for the steam railroads terminating in the State of New Jersey and is a collecting agency in the city of New York for passengers using the steam or surface roads from Jersey City and Hoboken to the suburban districts in New Jersey The layout of this railroad is now so well known that it is unnecessary to elaborate upon it except to draw attention to the fact the road has in New York both an uptown and a downtown terminus The former is located in the shopping district and is convenient to places of amusement, hotels and the residential district, and the latter is in the heart of the financial and business district For a road having the short mileage of the Hudson and Manhattan Railroad the traffic concentration is very great, in fact, as great as on any railroad in the city of New York and in studying the proposition of construction and operation it has been necessary to consider carefully the very great concentration of traffic and consequently to arrange all the details of construction and equipment for easy prompt and efficient handling of the public

There is no one who will disagree seriously with the statement that the public taken *en masse* is like a flock of sheep, extremely difficult to direct or handle and that it will at all times move in what it considers the lines of least resistance consequently the public moving as a mass is a very serious problem to be considered by those designing or equipping a transportation line The treatment of such a proposition must be done with a clear knowledge of the fact that one is dealing not with individuals but with masses or crowds and while the individuals composing the mass have sense and can be reasoned with and managed, the mass is unreasoning and often unreasonable, consequently nothing can be omitted in the design and equipment of a transportation line which will assist and direct a crowd so that it can have no possible choice in the matter of what it will or will not do Only by perfect arrangements in this respect can the railroad and its operating officials obtain the best results for the traveling public To obtain best results has been the constant effort of those who have had to do with the development of the Hudson and Manhattan Railroad

The original inception of the present system was a tunnel between the foot of 15th Street, Jersey City, and the foot of Morton Street, New York which had been started many years ago The company had undergone several reorganizations, and the property was finally acquired by the present holders at a foreclosure sale The property then consisted of a section of a tunnel of considerably larger internal diameter than the present tunnels driven from the New Jersey shore toward New York It was designed and partially constructed with the idea of being a terminus to be used jointly by the Erie and Lackawanna railroads, and while the construction of this short section made history in engineering considering that the promoter was really not an engineer at all, the use and operation of it were utterly impossible The portion of tunnel constructed was 18 feet internal diameter unnecessarily large for the ordinary street railroad or suburban railroad car but too small for two cars to pass and yet the tunnel was designed for a standard steam railroad car for which it was unsuitable In the first financing it was most essential to get a tunnel under the river to demonstrate the feasibility of its construction and after the long history of failure which had attended the early days of the Hudson River Tunnel Company it was desirable to establish the fact that such a railroad could be built and operated A plan was therefore prepared by which it was contemplated that the tunnel would be carried to the New York shore of the same diameter as the portion driven from the New Jersey shore and within this tunnel it was proposed to operate very narrow cars, somewhat along the lines of the cars first operated in the City and South London Railroad tunnel in London The tunnel was to be equipped with double tracks and operated as a double-track railroad in order that it might be of some service to the public and at the same time prove the feasibility of its construction and operation This plan also contemplated adhering to the original location of the road which provided for a terminal on the surface about midway between the Erie and Lackawanna Railroad stations in Jersey City It was proposed to divert the street railway cars to this terminus making it necessary to transfer passengers across a platform from the street railway cars to the narrow tunnels cars and *vice versa* In New York it was planned to have the narrow tunnel cars come to a depressed station at Christopher and Greenwich streets making the terminus at that location adjacent to a surface car line in New York Such an operated tunnel would have simply been a connecting link between the street railroads in Jersey City and Hoboken and the street railways in New York. It was very easily proved that such a proposition operating narrow cars as individual units would not be sufficient in capacity or rapid enough to handle the traffic and could not earn sufficient money to pay the interest on even the comparatively small capitalization necessary to complete, equip, and put in operation the doubletrack railroad in the single tube The next step was to complete a second tunnel with similar termini making a double-track railroad, through which could be operated standard street railway cars. Such a proposition would not be feasible as no one operating a tunnel railroad of this character would agree to operate it with anything but cars of steel and fireproof construction With the use of such cars no speed could have been attained except by coupling the cars and forming trains The undertaking proceeded on this general idea, but it was planned to construct the street railroad cars of steel and to couple them into trains and operate such trains through the tunnels with a full system of signals. The second tunnel was designed not only to take street cars, but also larger cars, if later on it were found desirable to equip the tunnels with larger cars for regular suburban service It was found that the termini as contemplated were poorly located for convenience of public service and quite inadequate and insufficient for practical use in handling a volume of business large enough to insure getting returns from the capital necessary, and considering that a public utility is primarily for the public use, it was decided not to spare any expense and to overcome all difficulties so as to make the project of the greatest service to the public. The terminus in

* Proceedings of the Engineers' Club of Philadelphia

New Jersey was the first one changed, and the location adopted was at the Lackawanna Railroad terminus in Hoboken, where all the surface and trolley lines of the Public Service Corporation of New Jersey from the north end of Hudson County terminate and where the Lackawanna Railroad brings a large suburban traffic over its lines. When the first tunnel was connected under the river to New York application was made to the Rapid Transit Railroad Commission for authority to change the location of the terminus in New York, for which the earlier franchise had been obtained to a point where it would be of real service to the public as well as an objective point for operation The result was the location of the terminus at Sixth Avenue and Thirty third Street.

Such is the brief history of the development of the Hudson and Manhattan Railroad and it may be of interest to present various points which have been carefully studied, considered and adapted for its particular business and special needs whereby the company has endeavored to carry out arrangements which place this road it is believed ahead of all others that have been installed in combining convenience and ease of operation with the least possible friction and discomfort to the traveler, and with the greatest possible efficiency and economical handling of traffic

Capacity—The first essential in the study of this railroad was to decide definitely on the capacity for transportation that could be furnished during the hour of maximum travel as this factor is the basis for regulating everything that comes after The dimensions of the property which could be acquired for stations either downtown in New York or at Hoboken where it was necessary to locate upon private property and not under the public streets fixed the greatest length of train that could be accommodated at 400 feet The curvature of the railroad as laid out particularly the short curves (radius 90 feet) entering and leaving the Church Street terminal made it necessary that the cars should be as short as possible and the truck centers so spaced as to reduce the overhang of the cars on curves to a minimum The cars in the Rapid Transit Subway in New York are 52 feet long but this length proved to be too great for the Hudson tunnels as an eight car train would be in excess of the maximum length of train that could be accommodated on a tangent in the stations After considerable study the length of car determined was 48 feet 3 inches when coupled with distance between truck centers 33 feet. All clearances in the tunnels and approaches had therefore to be figured in relation to this particular size of car The clearances in the tunnels allow for a car of the same width as the original subway cars (8 feet 10½ inches) which makes a roomy car satisfactory for passenger use The height of the car which does not affect the comfort of passengers was of necessity made low on account of the clearances The length of train determined upon was eight cars a total length of 386 feet A speed curve diagram was then calculated on the fixed characteristics of the railroad the train weights, and on the assumption that motor equipment would be installed on the cars to operate at a maximum speed of 45 miles per hour on level tangent The speed is reduced for station and junction controls on curves and of course on grades It was figured that station stops would be thirty seconds Experiments with the air brakes determined the safe braking distance on various grades throughout the tunnels at which the cars loaded and operated at the calculated theoretical speeds could be properly controlled The safe braking distance determined the spacing of signals and as the signal system is the double overlap type (that is to say, the position of a given signal ahead is indicated to an approaching train at two signal stations previous) the spacing of signals throughout the tunnels provides for the closest possible operation permissible under ninety seconds headway with eight-car trains The railroad is being operated on this interval successfully and regularly The train load and the minimum train interval indicate that it is possible to operate any portion of the road to the extent of carrying 32 000 passengers in one direction in one hour All the remaining factors entering into the design of a railroad operated for passenger service depend therefore on this one essential prime factor—maximum capacity

Stations—As in almost every road laid out, the general location of stations is one of the easiest matters to decide upon The questions involved are what points offer the greatest facility for the collection and distribution of passengers and how frequently stations should be located In this particular case the solution was even more simple than usual A terminus downtown in the heart of the business district was essential, and its general location had to be within quite narrow limits. The exact location was fixed by the property which could be acquired near Broadway, between Fulton and Cortlandt streets. The short length of, and the physical conditions on, the downtown line led to the conclusion that there would be no station but the terminal, and as arrangements had already been made with the Pennsylvania Railroad for a connection and for interchange of business, the first station in Jersey City was obviously under the station and tracks of the Pennsylvania Railroad. At Hoboken arrangements previous to this had been made for the occupancy of the under surface of property of the Public Service Corporation at the point where its trolley system terminates near the ferry and fortunately this location was adjacent to the Delaware Lackawanna and Western Railroad station so the use of this private property fixed the station at this point The tunnels extending from Hoboken to the Pennsylvania station pass under the property and yard of the Erie Railroad so a station was located at Pavonia Avenue for the interchange of passengers with the Erie Railroad and also with the trolley cars of the Public Service Corporation These points practically control all the local street railroad business of Jersey City and Hoboken as well as the great bulk of the steam railroad business coming to New York

In New York city uptown the local conditions make it necessary to have stations at close intervals to give proper facilities to the public and to connect with the intersecting street railway lines elevated railroad lines etc It was undesirable to locate stations even for local business closer than 1 200 to 1 500 feet which makes but a short distance for passengers to walk to or from intervening points and if the stations were located closer than 1 200 feet the trains could not gain sufficient speed between stations to give adequate service In the case of Hudson and Manhattan Railroad the stations except on Sixth Avenue are few and at long intervals The distance from Church Street to the Pennsylvania station is 1 2 miles from Hoboken to Christopher Street 2 01 miles and from the Pennsylvania station to Hoboken with only one intermediate stop—Erie Station—is 1 75 miles consequently very fast service can be given

Having decided upon the general location of the stations the next point was to determine upon a design for stations with a view of providing every facility and convenience for the traveling public When a railroad has to provide facilities for handling a concentrated travel of 32 000 passengers per hour in one direction and when that volume of traffic is likely to have one point as its destination as for instance Church Street Terminal New York and to a less extent the terminal at Hoboken then the design of the station is all important and it is particularly important with respect to regulating the length of time of station stops so as not to hamper operation and interfere with the regular maintenance of the prescribed train interval Some years ago it was thought necessary by railroad men to have at a station a large number of tracks where trains could stand a considerable time while being unloaded and loaded The conditions of suburban rapid transit service have necessitated a radical change from this old theory A steam railroad train made up of coaches equipped with platforms and steps at the ends by which passengers must leave and enter can only unload and load even in the most rapid suburban service at the rate of approximately 30 passengers per minute per car For steam railroad trains with cars having a seating capacity of about 60 passengers and no necessity whatever for making a short station stop this rate of handling passengers is still permissible but with rapid transit service, where it is not unusual to have a total of 115 passengers per car, this rate would be impossible Cars equipped with end doors at the level of the station platform as in the older types of elevated and subway cars permit the movement of only one person through a car door at one time It requires sixty seconds to unload a car of this type and if the train is then reloaded at the same point it requires thirty seconds to take on say one-half a car load As the movement in the contrary direction is never as heavy as the movement in the maximum direction and as the loading process cannot be begun until the unloading is completed it is obvious that this interval would be prohibitory under conditions of maximum service Further than this the fact of having a single platform from which to unload and load passengers simultaneously introduces a congestion on the platform which delays materially this movement and lengthens the necessary station stop Even the movement on street cars in or out is only at the rate of 50 passengers per minute through end openings and if one end is closed as in some of the modern cars of the pay-as-you-enter type when operated at terminals it is not unusual for passengers to enter at a rate of only 17 or 18 persons per minute and consequently to get a car loaded at such a slow rate as this interferes materially with the capacity of the road

At the Hoboken Terminal the Public Service Corporation has lately completed a terminal station, which is a new departure and ideal for handling efficiently these types of cars The station is inclosed and every passenger must buy a ticket and put it into a chopping box before entering the station the conductor has only to collect fares from passengers who get on after the car has left the terminal station In street service passengers usually get on or off in small numbers at any place other than terminals, and so if these terminal points are cared for, there is little difficulty in handling the passengers.

The result of numerous observations of all possible combinations shows clearly that the essential requirement of all station design for handling large crowds at terminals is to separate the movement of passengers so that cars are unloaded from one side and loaded from the other This does not necessarily apply at local stations where passengers are comparatively few and well distributed the movement can be made within the allowable thirty second station stop and with comparatively little inconvenience to the public The Church Street terminal (New York) Hoboken terminal and the stations now being constructed at Thirty third Street and Broadway New York and at Summit Avenue Jersey City therefore are arranged with platforms at the level of the car floor and with provision for loading trains from a platform on one side and unloading onto a platform on the opposite side

The next point to be considered in designing the station is the arrangement for handling passengers between trains and public thoroughfares without conflict In the movement It is most essential in any railroad proposition to control the movement of passengers as far as possible in the right hand direction and so far as possible to deliver the flow of passengers in one direction at points where they will not come in contact or conflict with the passengers moving in the opposite direction One of the most unfortunate features in an underground system is the necessity for taking passengers from station platforms below the level of the street and distributing them at the street surface and this necessitates in the cases of slight elevation stairs or ramps and in cases of great elevation escalators or elevators The movement of passengers in a straight passage either on a level or on a reasonable incline of 10 or 12 per cent is very rapid and when the movement is approximately in one direction it amounts to 40 persons per foot of width of passage per minute Consequently a comparatively narrow passage will accommodate a large number of people in a short period of time As soon as such a movement reaches a stair case however the rapidity is immediately reduced as the step taken by the passengers is shortened from about 30 inches to approximately 12 inches so that while the passenger may take the physical step as rapidly as when walking on a level surface the actual forward movement is perceptibly slower On broad staircases moving in one direction only and upward the number of passengers per minute averages 15 per foot of width whereas the maximum counted on any staircase under these conditions is 24 per minute If moving downward the average per minute under similar conditions is 13 and the maximum is 18 These conditions have to be taken into serious account when the necessity for staircases arises It is equally obvious that wherever conditions permit ramps should be provided instead of stairs as the accommodation provided by a ramp is very much greater and the use of a ramp is materially easier for the passenger

In the development of Church Street terminal where the concentration of people is likely to be excessive there could be no choice in the use of staircases for handling passengers from the platforms to the concourse level but the height of the concourse above the platforms was made as small as was possible allowing proper clearances for the trains The alternate platforms in this station are for loading the others for unloading so that the loading platform serves two trains while the central unloading platform serves two tracks the exterior platform is for unloading and of course serves but one track The arrangement of staircases from the unloading platforms is tandem on the centers of platforms and the direction is outward from the center of the platform There are six staircases to each platform three on each side of the center line of the platform—so that the distance from the exit door of a car to the nearest staircase is very short These staircases discharge passengers at the concourse floor in a direction pointing south to Cortlandt Street or north to Fulton Street thus delivering passengers on the concourse floor in the direction they desire to proceed On the other hand the staircases to the loading platforms lead from central points on the concourse floor to points along the train platforms and are so arranged that each loading platform has two pairs which enables the operating department to group the chopping boxes at the top of each of the two pairs of staircases and thus reduce during the slack hours the expense of ticket choppers ticket examiners guards etc Up to the present time no more efficient arrangements have been invented for examining and canceling tickets than the old barriers and chopping boxes The arrangement of stairs delivers passengers coming to trains at four points on the loading platforms more or less equally spaced and provides an equal distribution in the train loading At the Church Street terminal the space is sufficient to permit of distributing passengers on the concourse floor so that under the worst conditions of the maximum traffic there will be no congestion on this floor and the extremely broad ramps to Cortlandt and Fulton Streets and wide staircases to Dey Street provide free ingress and egress to and from the concourse floor.

(To be continued)

Cement Sidewalk Paving*

Simple Directions for Laying It

By Albert Moyer, Assn Am. Soc C E., M Natl Cement Users' Association

Cement sidewalk paving is a manufacturing industry whereby cement stone slabs are framed in place on the job Laying of this description has various uses Its principal use is a permanent path for pedestrians Among the other uses are driveways for vehicles, a floor wearing surface for buildings platforms in the stations of transportation lines wharf coverings cellar floors, curb and gutters The principal objects to be accomplished in manufacturing these cement stone slabs for the above named purposes are permanency durability and neatness

To accomplish permanency it is necessary that these slabs remain hard tough and in the original position for the average life of good construction work To achieve this object, correct methods of manufacture must be employed which will avoid settlement cracks, upheaval by frost and roots of trees crumbling due to work having been laid in freezing weather contraction cracks expansion cracks separation of top from base and disintegration

To avoid settlement cracks it is necessary thoroughly to ram the ground after excavating for foundation After drainage foundation has been put in place this should be thoroughly and evenly tamped so as to avoid any uneven strain The thickness of the slab should be governed by the factor of safety necessary to provide for the weight that is likely to be placed on any one slab It is estimated that a number of persons can be so crowded together as to cause a weight of from 100 to 150 pounds per square foot As the strength of the slab is not always governed by its thickness, maximum strength is obtained by properly proportioning the aggregates so that maximum density results.

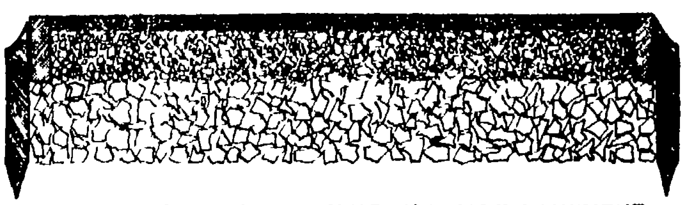


FIG 1 SECTION OF A CEMENT SIDEWALK PAVEMENT

To avoid upheaval by frost, a proper drainage foundation must be provided, such foundation to be carried to a sufficient depth so as to provide for perfect drainage; a drainage foundation is of use only in the event that it thoroughly drains Such a foundation is often placed so that it not only fails to acomplish the purpose for which it was intended, but practically defeats that object by causing an accumulation of water which in freezing upheaves the pavement A drainage foundation should have an outlet which has a fall of about ¼" or over to the foot If there is no natural outlet for such drainage, blind drain leaders should be provided at points along the walk where they are necessary These leaders should be formed of similar material as the drain itself with, possibly the addition of a porous drain tile leading into holes filled with cinders or crushed stone which will allow the surrounding earth to absorb the accumulated water

Upheaval by tree roots can very easily be avoided by cutting out any roots which will run under the pavement less than a depth of six inches under bottom of drainage foundation

Portland cement concrete expands and contracts in practically the same ratio as steel; it is therefore necessary to cut joints which will allow for this expansion or contraction The concrete must be cut entirely through with a cleaver, or other instrument, from ⅛" to ¼" wide, the blocks thus formed not to exceed 6 square. I am fully aware that very excellent work has been done, the blocks being as large as from 12 to 14 ; that good results were obtained with such large slabs is due more to favorable circumstances than to correct method. By figuring the expansion and contraction per degree between the heat of summer and the cold of winter, it will be found that we are only within the region of safety when the slabs do not exceed 6 with an ⅛" joint between each slab.

Expansion cracks are not due so much to the expansion of the cement stone slabs as to the expansion of other material bearing against these slabs; it is therefore advisable to cut the concrete away from the manholes, iron posts, etc., leaving about the same space in the joints as between the slabs themselves This space may be readily waterproofed by using felt paper painted with a good waterproof paint.

In the past it has been a very common practice to allow the base to set hard before laying the top coat; it is unnecessary at the present date to dwell on this subject; we all know that it is utterly wrong There are, however, other causes which prevent the top coat from adhering permanently to the base the principal cause being carelessness in allowing men to walk over the base carrying with them dust and dirt, also failure to protect the base, allowing the surface of the base to be exposed to the rays of the sun and thus dry the surface prematurely, at the same time allowing dust and dirt to blow over the surface, coating the concrete so that the top when placed fails to adhere permanently It is also absolutely necessary that the top be cut directly over the cuts in the base; otherwise the top coat will crack along the line of the joint in the base.

The principal causes of disintegration and chalky top surface are insufficient mixing, drying out before ultimate crystallization of cement, and bad material used. Start right and good results naturally follow To avoid disintegration material should be carefully selected. This selected material must be thoroughly incorporated and

FIG 2—CONCRETE MIXING PLANT SHOWING CONCRETE BOARD TOOLS ETC NECESSARY FOR MIXING CONCRETE BY HAND

*Reprint of a bulletin published by Vulcanite Portland Cement Company

FIG 3 LIFTING OFF THE SAND MEASURING BOX AND GETTING CEMENT READY

FIG. 4—SPREADING THE CEMENT OVER THE SAND

mixed into a plastic mass with sufficient water to bring about ultimate crystallization of the cement. Being thus mixed it should be immediately placed upon a cinder or broken stone foundation which has to be *soaked with water*, thoroughly and evenly tamped and then protected from drying out before final setting. Cement needs water not only when mixed, but after being placed and tamped and it requires water until ultimate crystallization has taken place. If any portion of the concrete is robbed of the amount of water necessary to bring about this result, the concrete is weakened to that extent.

It is important that the best material be used in the manufacture of Portland cement sidewalks. Poor material makes poor walks and costs just about as much.

Having selected the best materials obtainable, by far the most important operation is that of *mixing*. The methods employed in mixing by hand as well as by machinery depend largely upon the character of the aggregates used. It is now being almost universally recognized that the small aggregates properly graded in size make the densest, strongest and best concrete for sidewalk paving. Mix a concrete made of gravel, three-quarter inch hard limestone traprock or other hard tough stone and good coarse sand, by first mixing the cement and sand dry.

Following is the best procedure for hand mixing graphically described. (Written by Percy H. Wilson and Clifford W. Gaylord.)

The permanency of the pavement depends on careful and thorough mixing.

Showing the Quantities of Materials and the Resulting Amount of Concrete for Two-bag Batch, Using Natural Mixture of Bank Sand and Gravel

Kind of Concrete Mixture.	Proportions by Parts: Cement.	Sand.	Stone or Gravel.	Two Bag Batch: Materials: Cement, Bags.	Sand, Cubic Feet.	Stone or Gravel Cu. Ft.	Concrete Cubic Feet.	Size of Measuring Boxes Inside Measurements: Sand.	Stone or Gravel.	Water in Gallons for Medium Wet Mixture.
1 2 4 concrete	1	2	4	2	3¾	7½	8½	2 × 2 1 ½	2 4 11½	
1 2½ 5 concrete	1	2½	5	2	4⅔	9½	10½	2 × 2½ 11½	2 × 11½	1
1 3 6 concrete	1	3	6	2	5⅝	11½	12	2 × 3 11½	3 4 11½	8½

Showing the Quantities of Materials and the Resulting Amount of Concrete for Two-bag Batch.

Kind of Concrete Mixture	Proportions by Parts: Cement.	Natural Mixture of Sand and Gravel.	Two Bag Batch for Natural Mixtures of Bank Sand and Gravel: Materials: Cement Bags.	Natural Mixture of Sand and Gravel Cubic Feet.	Concrete, Cubic Feet.	Size of Measuring Boxes: Mixture of Sand and Gravel		Water in Gallons for Medium Wet Mixture.
1 2 4 concrete		4	2	[illegible]	8½	2 4	11½	10
1 2½ 5 concrete		5	2	9½	9½	2 × 5	1	9
1 3 concrete	1		2	11½	2	3 × 4	11½	13½

With the proper materials selected the next step is to mix properly and with dispatch. On large jobs it is more economical to mix concrete by machine, but for small jobs using even as much as several hundred cubic yards of concrete it is much cheaper and more expedient to mix by hand. This is of course especially true when only two or three men are available and the work is often in

FIG 5.—FIRST TURNING SAND AND CEMENT

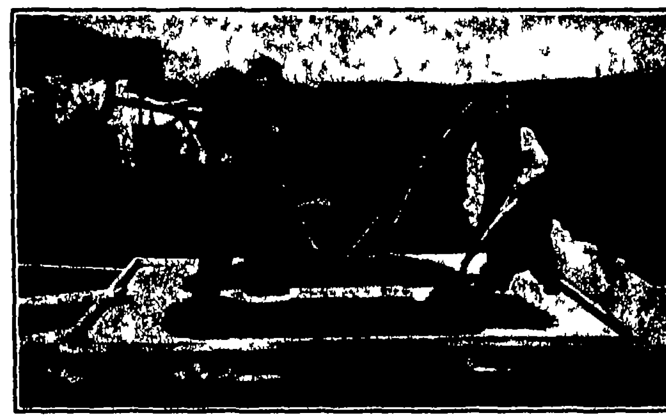


FIG 6.—SECOND TURNING SAND AND CEMENT

FIG 7.—FILLING THE STONE (OR GRAVEL) MEASURING BOX FIRST METHOD

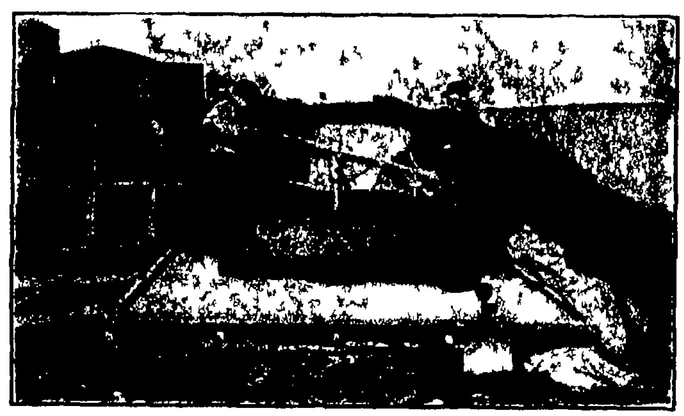


FIG 8.—FILLING THE STONE (OR GRAVEL) MEASURING BOX WHEN ON TOP OF MIXED SAND AND CEMENT SECOND METHOD

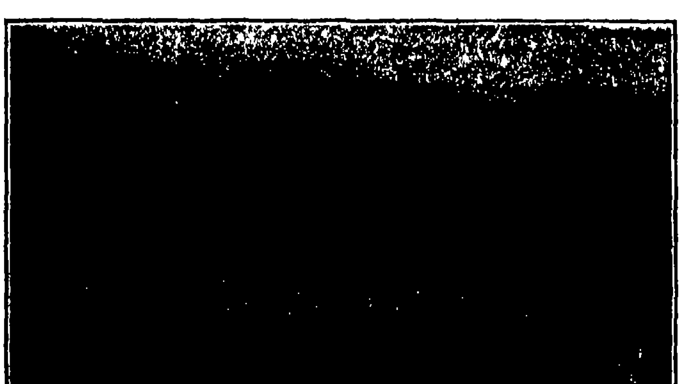


FIG 9.—PLACING THE WATER ON THE STONE (OR GRAVEL) WHICH IS ON TOP OF THE MIXED SAND AND CEMENT

FIG 10.—MIXING THE STONE (OR GRAVEL) WITH THE SAND AND CEMENT

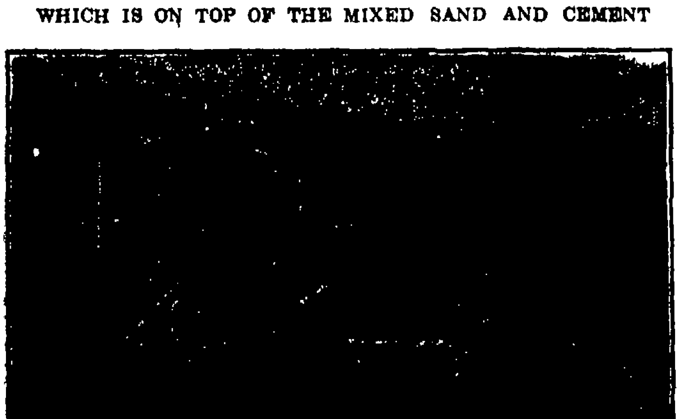


FIG. 11.—CONCRETE MIXED AND READY FOR PLACING

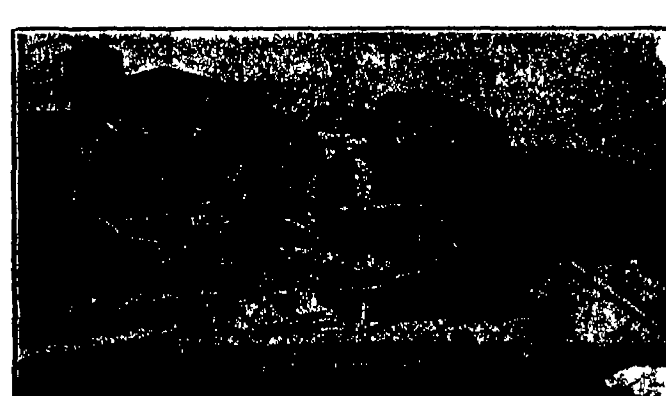


FIG 12.—PLACING THE CONCRETE WITH WHEELBARROWS

terrupted There are many ways of "hand mixing" all having the same good results The way described here we believe to be the one best calculated to obtain good results with a minimum of labor In this description and the accompanying illustrations, we have taken as a basis a Two Bag Batch

A concrete board for two men should be 9 feet × 10 feet Make it out of 1 inch boards, 10 feet long surfaced on one side using five 2 inch × 4-inch × 9 foot cleats to hold them together If 1 inch × 6 inch tongue and groove roofers can be obtained they will do very nicely if fairly free from knots The object of the surface boards is to make the shoveling easy The boards are so laid as to enable the shoveling to be done with and not against, the cracks between the boards The boards must be drawn up close in nailing so that no cement grout will run through while mixing Knot holes may be closed by nailing a strip across them on the under side of the board It is a good precaution against losing cement grout to nail a 2 inch × 2 inch or 2 inch × 4-inch piece around the outer edge of the board Often 2 inch planks are used in making concrete boards, but these are unnecessarily heavy and very cumbersome to move

Placing the Concrete Board—The concrete board is a manufacturing plant and the advantages of its location should be carefully considered Generally it is best placed as close as possible to the place in which the concrete is to be deposited but 'local conditions must govern this point Pick a place giving plenty of room near the storage piles of sand and stone (or pebbles) Block up your concrete board level so that the cement grout will not run off on one side and so that the board will not sag in the middle under the weight of the concrete

Do not use any old boards that are handy for the wheelbarrow runs Make a good run smooth, and at least 20 inches wide if much above the ground It is surprising how this one feature will lighten and quicken the work

List of tools and plant to be used in mixing giving sizes, quantities etc

Concrete board for two bag batch 9 × 10 in size *

Nine pieces ⅞" × 12" × 10 surfaced one side and two edges (any width of plank may be used 12 is specified only for convenience) 5 pieces 2" × 4" × 9 rough 2 pieces 2" × 2" × 10 rough 2 pieces 2" × 2" × 9 rough

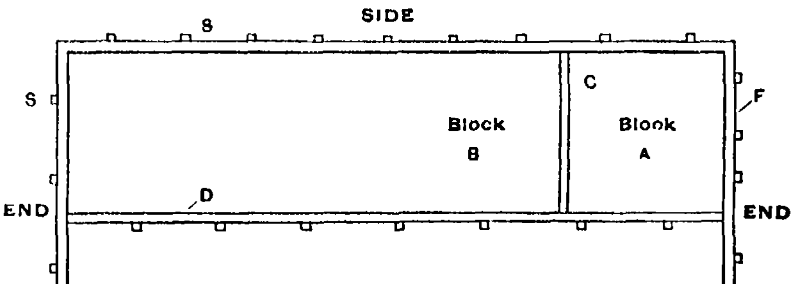


Fig 13—SEPARATION OF SLAB OR BLOCKS

C W od n strips x 3 inch lumb r (movable)
D L ng wood n strips x 3 inch lumber (movable)
F W den fram s 2 x 4 inch lumber t p of which coincides with estab ll hed grade of walk
S Stak s for h lding frame in position

Concrete board for four bag batch 12 × 10 in size:

Twelve pieces ⅞ × 12 × 10 surfaced one side and edges (any width of plank may be used 12 is specified only for convenience) 5 pieces 2" × 4" × 12 rough 2 pieces 2 × 2' × 10 rough; 2 pieces 2 × 2" × 12 rough

Runs—2" 2½ or 3" plank 10" or 12 wide

Measuring boxes for sand and stone or gravel

For two bag batch 1:2 4 mixture:

Four pieces 1" × 11½" × 2 rough 2 pieces 1" × 11½" × 4 rough 2 pieces 1" × 11½" × 6 rough

Note—The 2 pieces 4 long and the 2 pieces 6 long have an extra foot in length at each end to be made into a handle as shown in Fig 2

For two-bag batch 1:3:6 mixture

Two pieces 1" × 11½" × 2; 2 pieces 1" × 11½ × 3 2 pieces 1 × 11½ × 5 2 pieces 1 × 11½" × 6

Note—The 2 pieces 5 long and the 2 pieces 6' long have an extra foot in length at each end to be made into a handle as shown in Fig 2

For four bag batch:

Double cubic contents of boxes and order lumber accordingly

Shovels—No 3 square point

Wheelbarrows—At least two necessary for quick work; sheet iron body preferred

Rake

Water barrel

Water buckets Two gallon size

Tamper 4" × 4" × 2 6" with handles nailed to it as shown in Fig 2

Sand Screen—Made by nailing a piece of ¼" mesh wire screen 2½" × 5 in size to a frame of 2" × 4"

With the mixing board placed and the "runs" made the concrete plant is ready

First load your sand in wheelbarrows from the sand pile wheel on to the 'board and fill the sand measuring box which is placed about two feet from one of the 10-foot sides of the board When the sand box is filled lift it off and spread the sand over the board in a layer three inches or four inches thick as shown in Fig 4 Take the two bags of cement and place the contents as evenly as possible over the sand. (See Fig 4.) With the two men Fig 5 start mixing the sand and cement, each man turning over the half on his side. Starting at his feet and shoveling away from him, each man takes a full shovel load turning the shovel over on their own side. In turning the shovel, do not simply dump the sand and cement near the edge of the concrete board, but shake the materials off the end and sides of the shovel, so that the sand and cement are mixed as they fall This is a great assistance in mixing these materials In this way the material is shoveled from one side of the board to the other as shown in Figs 5 and 6 Fig 5 shows the first turning, and Fig 6 the second turning

The sand and cement should now be well mixed and ready for the stone and water After the last turning spread the sand and cement out carefully, place the gravel or stone measuring box inside it as shown in Fig 7, and fill from the gravel pile. Lift off the box and shovel the gravel on top of the sand and cement, spreading it as evenly as possible With some experience equally good results can be obtained by placing the gravel measuring box on top of the carefully leveled sand and cement mixture and filling it thus placing the gravel on top without an extra shoveling This method is shown in Fig 8 Add about three-fourths the required amount of water using a bucket and dashing the water over the gravel on top of the pile as evenly as possible (See Fig 9) Be careful not to let too much water get near the edges of the pile, as it will run off taking some cement with it. This caution, however does not apply to a properly constructed mixing board as the cement and water cannot get away Starting the same as with the sand and cement turn the materials over in much the same way, except that, instead of shaking the materials off the end of the shovel the whole shovel load is dumped and dragged back toward the mixer with the square point of the shovel This mixes the gravel with the sand and cement the wet gravel picking up the sand and cement as it rolls over when dragged back by the shovel (See Fig 10) Add water to the dry spots as the mixing goes on until all the required water has been used Turn the mass back again as was done with the sand and cement With experienced laborers the concrete would be well mixed after three such turnings; but if it shows streaky or dry spots it must be turned again After the final turning shovel into a compact pile The concrete is now ready for placing (See Fig 11)

Number of Men—For the above operation only two men are required although more can be used to advantage If three men are available let two of them mix as described above and the third man supply the water, help mix the concrete by raking over the dry or unmixed spots as the two mixers turn the concrete, help load the wheelbarrows with sand and stone or gravel, etc Fig 5 shows a third man on the board In this illustration he is helping mix the sand and cement by raking it—a most effective practice

When the day's work is done, carefully clean all the tools especially the concrete board Remove with a shovel all the loose cement, sand, and stone. Then scrub the board with a broom and water If this is not done, small particles of stone are glued to the board by the cement and render shoveling the next day most difficult

We again wish to call attention to the fact that there are several ways of mixing concrete by hand just as effective in their results as the ways mentioned here. But every man of experience in mixing has one way which he thinks is more effective and easier than any other

Machine mixing should be accomplished much the same as it is in Germany the mortar mixed dry then the stone added then the whole mass mixed dry; this entire mass is then run into another mixer and there mixed wet This result can be fairly well accomplished by using a mixer which has knives and rakes, which does the same thing as turning and raking in the hand mixed process; understand, I am advocating this method only for concrete made up of small size aggregates, that is, all passing a ¾" mesh.

Dry concrete, even though thoroughly tamped, seldom gives thoroughly satisfactory results

The object to be accomplished in laying a base for a sidewalk is uniform strength. The concrete to be of such consistency as will enable the workmen to place the top coat over the base during the same day and before the base has finally set. If the concrete is very wet, such as poured concrete, a scum forms on the top surface which interferes with the proper adhesion of the top coat to the base. Therefore, a happy medium should be found bringing about proper consistency which may be thoroughly and uniformly tamped. This can only be judged by the eye on the mixing board and is a matter which necessarily has to be left to experience.

The concrete should not be made so wet that it will quake under the tamping iron, unless steel strips are used for the joints or laid in alternate blocks; it should be sufficiently wet, however, so that some moisture rises to the surface under the tamping The proportion of water necessary will vary according to the climatic and other surrounding conditions The proper consistency can only be judged by the eye on the mixing board; no accurate specifications can possibly bring about uniform and desirable results. This is a matter which necessarily has to be left to experience. The tamping should be vigorous and uniform.

One of the causes of bad workmanship is due to the concrete either in the top or the base, having prematurely dried This is avoided by keeping the concrete covered to protect it from wind and the rays of the sun If the concrete is anywhere near boilers or steam pipes, see to it that the concrete is wet continuously for from twenty-four to thirty six hours; after this period sprinkle two or three times a day for a couple of weeks, or such length of additional time as economy will permit. Sidewalk paving slabs are acted on from both sides; and being comparatively thin are more sensitive than mass concrete therefore need greater protection. The writer has seen instances where workmanship as far as selection of materials, mixing, placing and tamping were thorough and excellent; but, nevertheless, bad results were obtained This was particularly true of a pavement laid over waterproofing The atmosphere absorbed the moisture from the top and the top absorbed the moisture from the base The base had nothing wet under it from which to get water could not supply sufficient moisture to the top to offset the action of the dry air and the result was a top of chalky consistency Had the base been made very wet and the top covered with wet sand, no such results would have been produced

Durability relates principally to the wearing surface; there is no reason why a cement slab should not wear longer than the ordinary natural stones; for, in forming these slabs we have the advantage of selecting the toughest and strongest stones Cement itself is tougher and stronger than most of the products of nature The texture of the surface has a good deal to do with efficiency A scum or skin of neat cement on the surface soon wears through, causing an ugly and blotchy pavement. There is no reason why a slab of cement stone cannot be manufactured which would wear for a hundred or more years; it might wear down to the extent of half an inch or an inch or more, and still preserve the same texture, This is perfectly feasible by making a slab of one piece no top coat whatever an even smooth top carefully jointed composed of small selected aggregates and in proportions which result in maximum density I have seen one or two pavements of this character notably the one around the Hotel Astor New York which is in 9" slabs entirely around the building expansion joints cut at regular intervals and so arranged as to form an architectural design The concrete was composed of three quarter inch traprock and sand The surface was floated off and smoothed down with a trowel; it was not troweled to such an extent as to bring any neat cement to the surface This pavement will wear for two hundred years or more and as it wears down the same texture is preserved

The usual troweled surface is slippery It is subject to all manner of diseases, such as hair cracks, crazing peeling etc and is only beautiful before the disease sets in A monolithic slab leveled off and smoothed to an even surface in which flint, quartz pebbles or crushed granite show through, such as some of our granolithic sidewalks can be thoroughly tamped and then floated so that the above desirable results are economically obtained Another method is to use three-quarter inch hard stone and quarry screenings or sand, making a monolithic slab straight edge off tamp uniformly smooth down to an even surface with float and trowel cut joints, carefully mark joints with a good jointer round the edges, and after final set is reached but before the surface has begun to dry scrub with a steel brush such as is used in cleaning boilers; play a hose on the surface just ahead of the brush and scrub the surface vigorously This removes the neat cement from the exposed surfaces of all the aggregates, does not disturb the aggregates, and gives a most beautiful, natural and genuine finish, similar to natural granite; you therefore have a pavement which is honest and genuinely clear through and is obviously so

The object of a top coat is durability, at the same time properly serving the purpose for which it is intended that of foot traffic A slippery sidewalk is a menace to humanity

In order to obtain durability neatness and good service, the top should be worked to a flat surface with a straight edge and smoothed down evenly with a float After the surface water has been absorbed and just as the top is hardening, it should be slightly troweled, but not enough to bring the neat cement to the surface, at the same time being careful to get an even surface avoiding float and trowel marks.

Neatness is obtained by the texture produced as described above, by carefully marking the joints and rounding the edges. Be careful not to use too much water so that an excess of water rises to the top, carrying with it particles of neat cement. This causes hair cracks, crazing, streaks and efflorescence. Another disease is occasioned by an accumulation of water in any one or more places which will cause what has been commonly known as water cracks, which are not open cracks, but surface cracks, and look like dark blotches. In discussing this

*For convenience the signs ' for feet and " for inches have been used in describing tools and plant in tables.

subject of neatness, observation would indicate that the thought uppermost in the mind of most sidewalk paving contractors had been that of forming an artificial top of veneer over the rougher concrete Do not use lamp black, it is the worse form of poor imitation Sidewalk paving construction, like all other forms of engineering, is only permanently and lastingly good if honest and genuine We will sum up the foregoing into the following suggested specifications:

SPECIFICATION SUGGESTIONS.

Sidewalks in cold climates where frost occurs should consist of a foundation of coarse cinders, broken stone brick bats, or other porous material, the concrete to be laid on this foundation Do not lay concrete in freezing weather

Excavate to a sufficient depth so as to provide for perfect drainage ram and tamp the ground thoroughly and evenly provide clean large cinders, broken stone or brick bats, any of which should be collected on an inch mesh place these to within the needed distance of the top of the established grade of the pavement (a sufficient number of inches to provide for the thickness of slab necessary to give adequate strength for the character of the work it is to perform) tamp this drainage foundation well and evenly thoroughly wet to saturation the cinders, stone or broken brick place in position wooden forms in a manner necessary to accurately outline the top and external edges of the walk the top of the form being located so as to coincide with the established grade of the walk place stakes nailed to and on the outside of forms or broad strips As an additional precaution and where necessary to accomplish the purposes of drainage, side drains should be placed every ten or twelve feet having a fall of not less than one-quarter inch to the foot, leading to some point forming an outlet for water which may accumulate This outlet should be below the frost line and it may be accomplished by a hole filled with cinders, stone or brickbats Cut out the roots of trees which lie less than a depth of six inches under the bottom of the drainage foundation

For a concrete base spread enough material to provide for the thickness of a slab which will come to within one inch of the top of the established grade; this concrete to be composed of one part Portland cement and two and a half parts sand or quarry screenings all passing one quarter inch mesh, and five parts broken stone or gravel all passing one inch mesh and collected on a quarter inch mesh; mix thoroughly

The specifications may be regulated if proportions can be obtained which will allow of a larger proportion of broken stone, at the same time giving maximum density Tamp the concrete to an even thickness cut the same into uniform squares of not over six feet square using a steel cleaver of not less than one-eighth inch and not over one quarter inch in thickness Cover the base with tarpaulins or tar paper immediately as each section is laid this as a protection against dust, dirt or premature drying Mark on the wooden forms the exact locations of these cuts After each batch of concrete is laid as required and before the base has started to harden it shall be covered with a top coat or wearing surface no dirt or dust having been allowed to accumulate on the base and the surface of the base to be wet or moist Any portion of the foundation which has been left long enough to have the appearance of setting or hardening shall be taken up and re laid before the top coat is put on

In order that the pavement may drain off readily during and after rain, the surface should be graded toward the street, having a fall of one-quarter of an inch to the foot causing the top nearest the street to be lower than the top nearest the buildings.

For wearing surface mix one part Portland cement with two parts crushed granite or other hard stone (all of which will pass through a quarter inch mesh screen) or good coarse sand mix by turning with shovels raking with a garden rake as each shovelful is turned turn twice dry and twice wet, add sufficient water to make a plastic consistency so that when floated or troweled very little water rises to the surface Spread this mortar over the concrete base to a thickness of one inch Work to a flat surface with a straight edge smooth down with float and trowel after the surface water has been absorbed be careful to get an even surface, bringing no neat cement to the surface and avoiding float and trowel marks

Cut the top surface directly over the cuts made in the base, cut entirely through top and base all around each block Finish the joints thus made with a jointer and round or bevel all edges

At the end of the day's work some careless workman often ends the work with an incline of concrete and when the work is started the next morning new concrete is spread over this incline of concrete which has set hard While a bond may result it will at best be very weak resulting during the course of a month or two in a crack at this point.

The day's work should be ended at the end of a slab A form should be staked across making a vertical joint, a piece of thick tar paper should be placed against this vertical joint and the new concrete placed against this tar paper

As an alternative and instead of using a top coat, make one slab of selected aggregates for the face and wearing surface, filling in concrete between the frames flush with the established grade Concrete must be of selected aggregates all of which will pass through a three-quarter-inch mesh sieve, hard tough stones or pebbles graded in size, proportions to be one part cement, two and a half parts crushed hard-stone screenings or coarse sand (all passing a quarter-inch mesh), and five parts crushed hard-stone or pebbles, all passing through a three-quarter-inch mesh, and all collected on a quarter-inch mesh; tamp to an even surface, prove surface with a straight edge, smooth down with float or trowel Thoroughly mix.

Do not allow any block to bear directly against any solid body, such as stone curb, building, post, manhole rim, etc. Leave the same space (about one-quarter inch) between the pavement and such fixtures as are between the blocks themselves. This applies to the base and top as designed to avoid cracks and chipping due to expansion and contraction from temperature changes This space can be conveniently provided for by the use of thick tar paper or felt, waterproofed with any of the reliable waterproof paints

When finished cover the pavement so as to protect it against the rays of the sun the wind and consequent drying raising the covering a few inches so as not to come in contact with the surfaces after the pavement has reached hard set, sprinkle frequently two or three times a day with a garden hose or a sprinkler for a week or more

SIDEWALKS.

Another method designed to insure perfect separation of slab or blocks (See Fig 13)

Place a 2 × 3-inch strip *D* parallel with the side of the walk in such position as will form square blocks of equal dimensions, not over six feet wide; brace the same with stakes but do not nail to the frame then cut a strip 2 × 3 inches, the length of which is to be the width of the blocks or distance between strip *D* and side frame *I* Place this strip so as to form a square block *C* On the inside of the strip *C* and *D* place thick tar or felt paper ¼ inch thick and 3 inches wide fill in the space thus formed (block *A*) with concrete composed of one part Portland cement two parts sand and five parts crushed stone or gravel, and mix thoroughly Tamp the concrete thoroughly to an even thickness then remove strip *C*; the tar paper will adhere to the concrete Move strip *C* to the next position skip block *B* place the thick tar or felt paper as before and proceed the same with each block laying alternately Put on the top coat before the first block made starts to set or harden and in regular order as blocks were made

CEMENT SIDEWALKS IN WARM CLIMATES WHERE FREEZING DOES NOT OCCUR.

Excavate to a depth of 4 inches below established grade of the sidewalk tamp the ground well and evenly omit the cinder or broken stone drainage foundation remainder of specification same as that for sidewalks in cold climates

DRIVEWAYS

Base should not be less than 4½ inches thick

Wearing surface should not be less than 1½ inches thick; remainder of specification same as for sidewalks

CELLAR FLOORS

Use sidewalk specification with the exception that the cellar should be waterproofed outside the sides carrying the waterproofing down outside of the wall over the top of the footings in addition lead off water by outside drainage obtained by porous drain tile covered with cinders or broken stone run around the wall just below the top of the cellar floor, leave out the drainage foundation and do not cut the concrete into blocks A two-inch to four inch thickness is sufficient

COLORING MATTER.

Do not use coloring matter unless absolutely necessary Nearly all coloring matter reduces the strength of the mortar For coloring cement work the following quantities will be found the least objectionable

QUANTITIES PER 95 POUNDS OF PORTLAND CEMENT

For a 1:2 mortar

		Pounds
Black	Excelsior carbon black	2
Black	Manganese dioxide	10
Buff	Yellow ocher	4
Blue	Ultramarine or azure blue	4
Gray	Lamp black (bone black)	½
Green	Ultramarine	5
Green	Oxide of cromium	7
Brown	Roasted iron oxide	6
Red	Red iron oxide	6 to 10
Bright red	Pompeian red	6
Yellow	Ocher	6

Mix the coloring matter thoroughly with the sand or screenings in proportions as above

CEMENT CURB AND GUTTER

The drainage foundation should be of materials as described under the head of sidewalk paving and placed so as to accomplish the object of drainage, using the methods and instructions as previously described.

Place in position the forms to receive the concrete. These forms are held in place by stakes set by the engineer at points necessary to accurately designate the line and grade of the proposed curb and gutter (See Fig 14 *A B* and *S*) For forms use 1½ to 2 inch rough planks Dimensions to be according to the height of the curb and thickness of the gutter Form *F* is movable and is held in place by iron clamps bearing against the outside of form *B* extending over the top of the curb this clamp being shaped similar to the letter C, one of the arms being fitted with a screw

Spread five or more inches of concrete mixed as described under the head of Cement Sidewalk Paving The concrete should be mixed wet so that when tamped some water will come to the surface Then place in position form *F* and fill in with concrete the same mixture between form *F* and form *B* tamp thoroughly and evenly to within one inch of the top of the curb; form *F* may be taken down immediately and moved to next position Form *B* will be found sufficient to hold the concrete curb in place without sagging Cut curb and gutter entirely through every six feet A convenient and sure method is to use a piece of quarter inch sheet iron the height and width of the curb and gutter as a division partition fasten a handle on top and shape the sheet iron the same form as the concrete base of curb and gutter (See Fig 14 *C* and *D*) Place this sheet iron division every six feet between forms *A* and *B* tamp concrete all around on both sides of the sheet iron form pull out the same immediately after form *F* is removed Fill in the cuts thus formed with dry sand mark forms *A* and *B* opposite cuts so as to accurately place the joints thus formed After each batch of concrete is laid it should immediately be covered with a top coat of wearing surface

Cover the concrete base of the curb and gutter immediately or as soon as possible after the base has been put in place with one inch of mortar mixed medium wet Materials used for this mortar and methods of mixing to be as previously described in specifications for Cement Sidewalks

Slope the gutter to meet the requirements of drainage by increasing the thickness of the top coat on the side nearest the street Work to an even surface with a straight edge laid parallel with the curb and shifted from form *B* to form *A* The upper face corner of the curb and angle between the curb and gutter should be rounded with a radius of 1 to 1½ inches After getting a good surface float with plasterers float until a smooth, even surface is obtained This surface should be wet or very moist. Dust this surface while it is still wet with granite dust and Portland cement mixed half and half dusting to take place before the surface water has been absorbed Immediately smooth down with a trowel Do not let too great an interval elapse between floating and troweling Use a curved trowel for top corners of the curb and angles between the curb and gutter After troweling finish with a soft brush, an ordinary hearth brush or whitewash brush will do If the top is too dry sprinkle with water The brush will take out the trowel marks and give an even texture and color to the finished work Cut the top coat directly over the cuts made in the concrete base leveling the edges of the cuts with a jointer

Protection is most important and is fully covered by instructions previously described under head of Sidewalk Paving

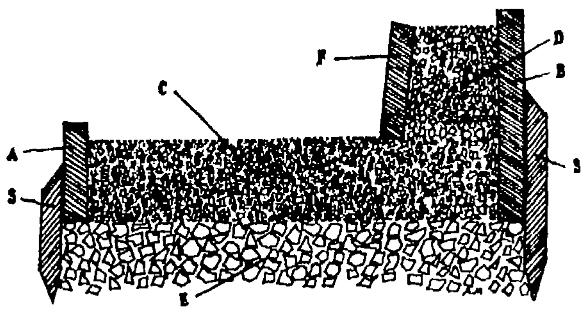


FIG 14 CONCRETE CURB AND GUTTER SHOWING DRAINAGE FOUNDATION AND CONCRETE BASE (TOP COAT NOT SHOWN)

A—Plank 1½ inch x 6 inches length as required
B—Plank 1½ inch x 13 inches length as required
C—Concrete base for gutter and under part
D—Concrete base for curb
E—Drainage foundation
F—Plank 1½ inch x 7 inches length as required
S—Stakes nailed to forms *A* and *B*

A Catskin Carriage Robe

HAVE you ever seen a catskin carriage robe with the skins in their natural colors? If not, you would be as much surprised at its beauty as the writer was when a young nephew who was visiting me from the country brought his robe out for admiration It was really beautiful but it seemed also remarkable as the handiwork of a boy not yet seventeen He had bagged the cats of all the neighborhood killed them and tanned the skins But the lining was still more remarkable It was of blanket like material and this boy had himself taken the wool as it came from the sheep washed it dyed it spun it into yarn put the yarn on a loom and had woven it into the cloth, thus alone completing the production of the cloth lining His father had a small woolen mill driven by a water wheel and covering a floor space of probably 40 × 60 In these days, when the large factories specialize labor so that different persons perform the different steps in the production of a cloth, it seemed remarkable that the boy should have, single handed converted the raw material into the beautiful finished article.

A Few Shop Jobs on an Old Car

Hints for the Handy Man with Tools

By Herbert L Towle

Aside from repairing actual breakages which are not covered in this article the work of overhauling an old car concerns itself first, with making good the wear due to use second with altering or modernizing certain features such for example as the ignition system to bring them up to date and third, with an intermediate class of repairs necessitated by such things as sagging of the frame or axles or bends in the steering connections which cause the front wheels to run out of line In most cases of wear or distortion the proper remedy suggests itself at once to the experienced shop man In many cases however the severity of automobile service is such as to require much more careful treatment than would be necessary with other classes of machinery A few typical instances are noted in the following paragraphs

MAKING A STEERING GEAR SNUG

The steering gear is usually the first part of a car to show wear owing to the violent shocks it must endure and the necessarily limited sizes of the various bearings A common fault in old cars is loosening up of the bolts holding the casing at the base of the steering column to the frame Unless the steering column is well braced to the dash or toe board the slightest looseness in these bolts will cause the steering column to shake and the bolt holes to wear large Tightening up the bolts is but a temporary make shift. The only permanent remedy is to ream the holes true and fair to the next larger size and put in bolts that are a tapping fit in the holes It may even be worth while to make special bolts for the purpose from annealed tool steel A better remedy where it can be applied is to brace the steering column This requires that the dash or toe board itself shall be rigid A simple method is to make a brass casting to fit the dash or toe board having a cored hole a quarter of an inch larger than the steering column After being put in place this casting is heated and babbitt metal is run in to fill the space around the column If the outside of the column turns thin paper must be wrapped around it to give clearance and the babbitt bearing must be 4 or 5 inches long and provided with a grease cup

In case the steering knuckles are worn loose on their pivot bolts renewal is easy if the knuckles are bushed If however there are no bushings the knuckles may be counterbored and case hardened bushings driven in These bushings of course should be case hardened inside only and copper plated and wrapped with asbestos before baking to prevent their outer surfaces from absorbing carbon The same treatment may be applied to the ends of the front cross link or the holes may simply be reamed true and pins made and case hardened to fit them If new pins are made they should be provided with oil covers or better small greasecups and able to bronze Quite possibly the crank pins of the engine under consideration are oiled by splash from above through holes drilled in the upper half of the connecting rod big ends If so the repair man has a good opportunity to prolong the usefulness of the next set of bushings by leaving the upper half entirely plain and feeding the oil from beneath by means of copper or steel scoops sweated into the bottom caps of the rods These scoops should be about one-quarter of an inch inside diameter and shaped to dip squarely into the oil Short oil grooves should lead crosswise from the oil hole in the center of the bushing but these grooves should extend no more than half way to the edge of the bushing so that the oil will not be able to escape from the bearing without doing its part of the work In handling connecting rods with scoops fitted care must be taken not to bend the end of the scoop by an accidental blow as this would defeat the object of the scoop and result in a cut bearing The reason for leaving the upper half of the bushing plain is that under pressure oil squeezes out from a bearing instead of working into it and grooves in the pressure side would permit the oil to escape at the very moment when it was most needed

SAGGED FRAME

A motor car frame is after all nothing but a spring, and it sags more or less according to the load. In time the shocks of travel may produce a permanent set in the side members, to compensate for which the motor and gear case should be lined up anew It is a good plan when doing this to load the frame in some manner to about its normal load If the sag

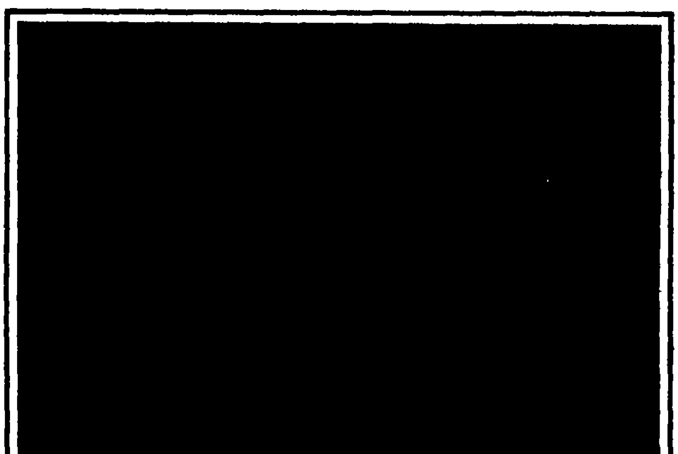
ROUNDING UP AN OLD CRANK-SHAFT

is small it can usually be corrected by putting liners under the rear feet of the engine and the front feet of the gear box Exact alignment is unnecessary if the clutch and gear box are connected by a short shaft having universal joints at both ends If however there is only one universal or none at all, fairly exact alignment is necessary An approximate test is had by opening all the compression cocks and turning the crank slowly with the clutch engaged to show whether or not there is binding at any point.

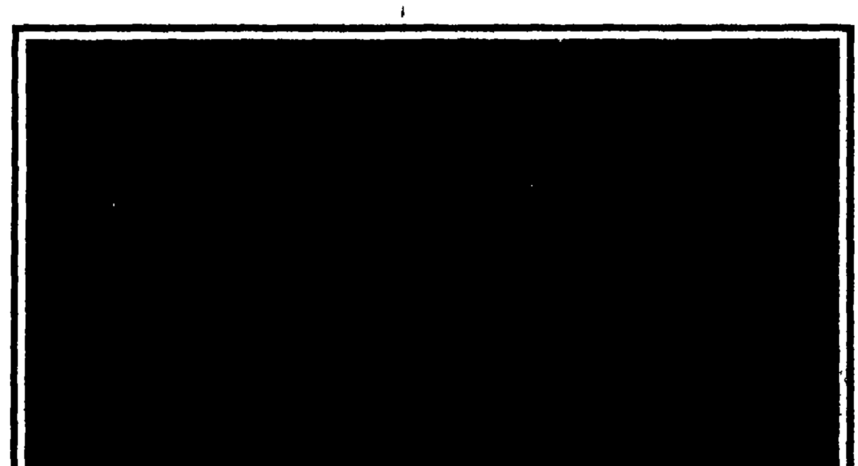
If the frame has sagged so much that liners used as above will not correct the trouble it is best to apply truss rods underneath the frame The manner of doing this will depend on the room available for attaching the ends of the truss rods and for placing the two struts According to the size of the car the truss rods may be from ⅜ inch to ½ inch in diameter and the struts may be from 4 inches to 6 inches high It is best to attach the ends of the truss rods beyond the spring shackles and if possible over the axles The struts may be spaced apart about one third the distance between the ends of the rods The rivets holding the ends of the rods should be spaced fore and aft and should be about 5 16 of and inch in

WEAR OF PISTONS AND CYLINDERS

The piston rings will become leaky before the pistons have ceased to be a fair fit in the cylinders consequently replacement of the rings may be the only thing needed In time however the cylinder wears barrel shaped and the piston also wears with the result of oil working up past the pistons in undue quantities till a noticeable click is produced at each explosion by the side slap of the piston When this point is reached the cylinder must be reground and a new piston turned to fit. The clearance between the piston and cylinder should be approximately one thousandth inch plus another thousandth for each inch of the piston diameter That is a 4 inch piston should have five-thousandths of an inch clear ance The top of the piston should have when cold at least double the clearance given elsewhere, on account of the expansion of the piston head when hot.



REPAIRING A CRANK CASE



GROOVING A PISTON

MAKING YOUR OWN AUTOMOBILE REPAIRS

these should feed to the center of the bearing

LEAK IN RADIATOR

A radiator may be repaired if the leak is outside, by emptying it and laying it flat so that the solder will not flow away To prevent adjacent seams from opening from the heat they may be kept cool with pads of wet waste

NEW CRANK SHAFT BUSHINGS

Die cast babbitt metal is now almost the universal material for crank shaft bushings and is far prefer-

diameter, two to four being used, according to the size of the rod A turnbuckle in the center of the rod will draw the frame straight

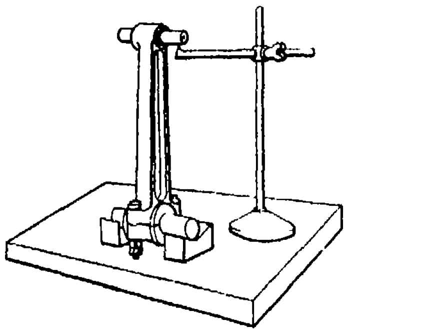
BALL BEARINGS LOOSE IN GEAR CASE

Annular ball bearings set directly into an aluminium crank case are liable in time to hammer their aluminium seatings until the outer races are distinctly loose This is avoided in some cars by setting the bearings in bronze cages, thus distributing the contact between the outside of the cage and the aluminium over a larger surface than the outer ball

race itself would afford. In case a ball bearing works loose in aluminium the best remedy is to counter bore the aluminium about ¼ inch larger each side and machine a flanged bronze ring to fit the aluminium as snugly as possible

FILLETS ON SQUARE-ENDED SHAFTS

It is quite common for the shafts in live rear axles of the floating type to engage the differential gears by having square bolts milled on the shaft ends Quite possibly the outer ends of the shafts may engage driving plates in the wheel hubs in the same manner If the car has side chain drive the differential shafts may have their inner ends formed in the same way and the outer ends may have tapered ends with hexagonal flats to hold the sprocket pinions The best modern practice is either to have the shaft enlarged so that forming a square or hexagonal of it does not reduce its section below that of the end portions of the shaft or to forge a disk on the end

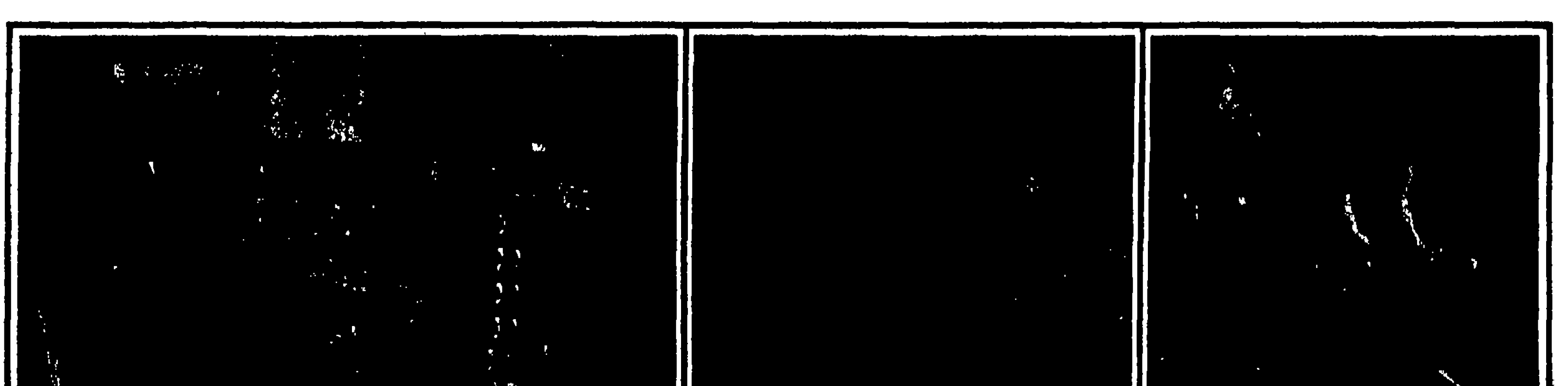


TESTING WRIST AND CRANK PIN BUSHINGS FOR PARALLELISM AFTER SCRAPING THE LATTER

of the shaft with bolt holes or clutch claws on it the purpose of either construction being to apply the driving force at a greater distance from the center of the shaft If however the shaft is not enlarged it is very important that the change from the reduced square to full circular section be gradual not abrupt An abrupt shoulder at this point concentrates the fiber stress and results in the shaft eventually breaking under strains which it would have easily endured if large fillets were provided instead of a square shoulder The same thing applies to hexagonal ends If the shaft is taken out in the course of overhauling fillets can easily be put in by means of an emery wheel

WELDING CRACKS IN ALUMINIUM CASTINGS

Until recently it was necessary either to discard a cast aluminium part belonging to the crank case or gear case in the event of its being cracked or to rivet a more or less unsightly patch over the crack to close and strengthen it. Nowadays such work is done by oxy acetylene welding The process of course cannot be described here but it consists essentially in chipping a triangular groove of the width and depth of the crack and filling this groove with molten aluminium flowed into it under the heat of the oxy acetylene blow pipe flame The same process is applicable to repairing cracked water jackets and occasionally cylinders as well as repairing damage of various sorts to wrought iron and steel Portable apparatus for this purpose may be had in the market



SOLDERING A LEAKY RADIATOR

REGRINDING A CYLINDER

REBUSHING THE BEARINGS

HOW AUTOMOBILES ARE REPAIRED

and should be a part of the equipment of every first class automobile repair shop

REFITTING THE DIFFERENTIAL

The hardest part of the differential to lubricate and the likeliest therefore to wear out soon is the spider, on which the four small bevel pinions are carried The spider is usually case-hardened the pinions may or may not be bushed Holes are usually drilled in the pinions through which oil is worked by the rolling of the teeth If however the user makes the mistake of using grease to lubricate his differential, the repairer is likely to find that the bushings of the small pinions have been cut to pieces, owing to the grease refusing to enter The journal portions of the spider are also likely to have suffered If the pinions are bushed the user is fortunate, for new bushings are easily purchased and even if the spider must be ground to true it up special bushings to fit the new diameter of the spider will not be expensive If however there are no bushings, both pinions and spider must be replaced

RERIVETING AN OLD FRAME

Most of the frames made to-day are as strong in the riveted joints as elsewhere Occasionally however one may find a frame which through long service has loosened up its joints and must be reriveted to make it sound This involves dismantling the entire car and taking the frame close to a forge as the riveting must be done hot to be secure Before riveting the holes should be reamed to make sure that they line up evenly and are the proper size for the rivets selected The frame members must be carefully cleaned after the old rivets have been cut out as dirt between the surfaces will spoil the tightness of the job.

TAKING UP PLAY IN SPARK AND THROTTLE CONNECTIONS

In few cars are the spark and throttle connections so carefully made that they don t work loose after the car has run a few thousand miles When that point is reached either the operator must depend on guess work and knack when running slowly or springs must be attached to take up the slack and exert constant pressure in one direction The latter expedient is simple and in most cases sufficient However a first-class job can be done at small expense by purchasing the ball jointed rod-ends manufactured for this purpose and sold to the trade These ends are usually made to screw over 3 16 inch rods or to screw into tubing of the same inside diameter being of the ball joint type they are flexible in any direction

OVERHAULING THE IGNITION SYSTEM

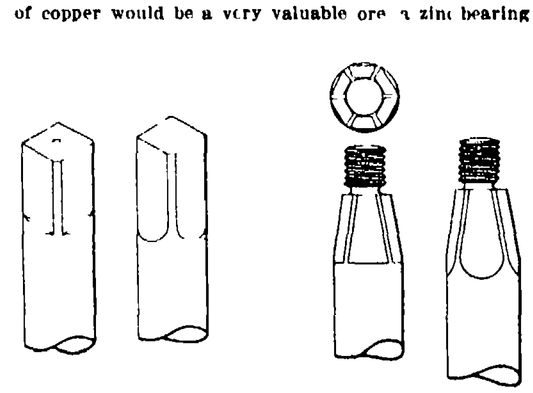
The winter is the proper time for making any changes which may be desired in the ignition system The number of reputable high tension magnetos at present available to the user is sufficient to afford little excuse for disappointment in this important item of equipment If the price of a high tension magneto is an obstacle the user can purchase at a reasonable figure a battery system of high-current economy and great reliability which produces a single spark for each ignition and requires only common dry cells as a source of current

The Outlook for the Future of Zinc Production

In making a forecast of the probable future development in the industries of the most important metals Prof J A Kemp takes up among others the case of zinc with regard to which he says

Zinc is a metal of comparatively late introduction into commerce in the large way Although known for centuries it has found its chief applications in the last sixty years There was no zinc mine in the United States until approximately the year 1860 and from the Missouri region whence we now obtain our chief supplies the really serious contributions began about 1870 Lead indeed was mined and prized long before this but the associated zinc ore was thrown one side on the dumps In the west the same experience continued until much later Zinc was a nuisance in the metallurgical treatment of lead and even the lead was sought and smelted either because of its own silver contents or because it made possible the treatment of other refractory silver ores In the metallurgical work the zinc was volatilized or slagged off and was lost Indeed one of our most serious metallurgical problems has been the successful treatment of lead zinc ores and many investigators have addressed themselves to its solution Now that anxiety is beginning to manifest itself regarding zinc supplies for the future the desire to save it is stronger than ever

Zinc however is a peculiar metal and because of the exigencies of its treatment its ores must possess greater richness and greater purity than those of other base metals Thus in the case of copper a ten per cent ore is in later days phenomenally rich and as it can be smelted in a shaft furnace the presence of iron or lime or other bases that make fusible slags is an advantage But zinc ores perhaps after preliminary roasting must be reduced and the metal must be volatilized at a high temperature from a small charge in a retort The presence of fusible bases destroys the retort and the bases are therefore debarred beyond certain small percentages Thus it happens that a forty or fifty per cent zinc ore might be valueless if contaminated by iron or lime beyond a narrow margin While almost any conceivable mineralogical aggregate that contained ten per cent of copper would be a very valuable ore a zinc bearing



BALANCED SQUARE AND HEXAGON ENDS OF SHAFTS

aggregate with four or five times as much zinc might be unsalable

In 1907 the United States was the chief producer of zinc among the nations but as a rule Germany leads followed by this country and Belgium in the order named In late years our output has varied from 26 to 30 per cent of the total As a rule Germany is 2 to 4 per cent in excess of us and Belgium is 4 to 5 per cent less

In America Missouri is the chief source of zinc Its production from the mines was in 1908 approximately one half the output of the entire United States New Jersey follows with somewhat over one quarter the total while all the rest are much smaller

The Missouri ores as thus far produced have been obtained from comparatively shallow depths They extend lengthwise and sometimes laterally to greater dimensions than vertically While it is not beyond the possibilities that lower lying deposits may be discovered since zinc ores are found in Arkansas in strata of lower geological position anticipations of this reserve have not as yet been demonstrated on a large scale

In New Jersey the future is best forecast of all For thirty or forty years there is no occasion of anxiety Yet thirty or forty years pass quickly and then we must prepare to look for other sources To make the zinc blende of the Rocky Mountain region available an increase in price is practically necessary otherwise the metal can not stand the freight charges There is zinc ore in the west but to what extent we cannot well say It has been avoided rather than sought in most of our mines Yet we do note symptoms of attention to it In Butte Montana efforts are being made to concentrate it Shipments of oxidized ores have been made from New Mexico for some years past Until recently large amounts of peculiar appearance seem to have been overlooked at Leadville Colorado They promise to be an important resource A government commission has reported upon the occurrence of the metal in British Columbia in the hopes of utilizing the ores From Mexico too, we learn of explorations for zinc Conditions are changing in the case of this metal.

and more and more of it is certain to be brought from remoter localities But when we look a long way ahead say for a century we cannot feel free from anxiety The condition of mind is even more prominent in Europe than in America. The waning of the famous old mines near Aix la Chappelle, and the apprehensions felt regarding other sources have lead to a world wide search Zinc ores for example now reach Hamburg from the Pacific shore of Siberia, and as other discoveries are made additional points remote from present smelting centers are likely to be shippers, provided that transportation is by water Nevertheless, all these new conditions call for advances in price, and before many years zinc bids fair to take the upward course

Modern Scientific Research*

Its Object and Methods

By Sir William A Tilden, F R S

Research is a word much used in newspapers and in public discussions nowadays but few people outside purely scientific circles have any clear idea as to its meaning Of course the dictionary tells us that it signifies a searching again or a careful search but the question then arises What is the object of the search and are there any rules to guide?

The object may be purely visionary as was the object of the early chemists and alchemists whose operations extending through the dark centuries of the Middle Ages left behind practically nothing but an extensive though barren literature the witness of the credulity and ignorance of those times The lesson to be derived from the whole of this strange history is one which needs to be continually revived and set in the new light of modern discovery and invention The lesson is simply that until men began to observe and interrogate nature for the sake of learning her ways and without concentrating their attention on the expectations of useful applications of such knowledge little or no progress was made In other words until a sufficient foundation of pure science has been successfully laid there can be no applied science Real progress comes from the pursuit of knowledge for its own sake

I say again this truth needs to be continually reiterated for there are still too many people who think that the true and only business of science is to find out useful things and who regard all the rest as waste of time

The first qualification for research is undoubtedly that kind of inspired curiosity which can never be eradicated and which we know by many examples is not defeated by such obstacles as poverty or ill health or pressure of other necessary occupations Another qualification is some knowledge of the subject chosen for inquiry As to this latter qualification considerable differences of opinion have been expressed Priestley whose statue stands near the Town Hall in Birmingham and many of the chemists of his time had very little preparatory instruction but some of them made discoveries of fundamental importance Priestley seems to have been of opinion that very little preparation is necessary and the discoveries which might result from experiment were regarded by him as largely the result of chance and to be compared with the game which might fall to the gun of a sportsman in a new country and whether fur or feather cannot be foretold But though this might have been partly true in Priestley's time it is certainly very far from true in our day when the accumulation of knowledge however imperfect is still immense

Every great discovery is the culmination of a long series of discoveries each of which is a necessary step and ignorance of these preliminaries stands in the way of advance

It will be worth while to examine a few cases by way of illustration No better example can be found than the establishment of the great principle in chemistry commonly called the periodic law According to this law the properties of the elements and of their compounds stand in a definite relation to their atomic weights

Modern views concerning the constitution of gases afford another illustration of the way in which the possession of one kind of knowledge leads to more knowledge Forty years ago students were led to believe that there were two kinds of gases namely on the one hand those which by the action of cold or pressure or both together could be liquefied and on the other hand some half dozen which could not be reduced to the liquid state This was attributed to some fundamental difference of constitution in the two kinds of gas

If we look for an example drawn from the domain of biology there is the doctrine of evolution now universally accepted which is based on the results of the patient collection of facts by Darwin and Wallace But those facts would perhaps not have been collected and they would certainly have been without meaning but for the results of the study of comparative anatomy by previous generations of naturalists and palæontologists as well as the recognition of the great doctrine of uniformitarianism in geology proclaimed and established by Lyell

The examples cited will not appeal to the practical man in the same way as some instance taken from a direct application of science to business or practical affairs If it is really necessary to consider a case of that sort nothing could be better than the *dynamo* which as a transformer of energy comes into prominent daily use in connection with lighting traction and as a general motive agent The detailed history of the evolution of the dynamo would be a long story and on this occasion it is only necessary to point out one or two facts For the fundamental principles involved we must go back to Benjamin Franklin and Galvani and Volta, all in the eighteenth century and later to 1831 when Faraday discovered the generation of induced currents by moving a conductor in a magnetic field But doubtless the experiments made by Franklin with the kite by Galvani on frogs legs and by Volta and Faraday with bits of wire were by the people of their day looked upon with a mixture of amusement and contempt just as some people even at the present time are apt to exclaim Who cares whether there is oxygen in the sun?

It is obvious then that whatever may have been possible in Priestley's time the wholly unrestricted person cannot expect to meet with much success in these days in the discovery of new facts and although the exceptional man may acquire in a very short time some knowledge of a special part of a subject he is in perpetual danger of falling into great mistakes It seems to me that a considerable amount of knowledge skill and experience is an indispensable equipment for anyone who enters seriously into the practice of scientific research Not that these qualifications alone serve as inducements to such a career for it would be quite easy to point to examples of learned people who have added nothing new to the branch of knowledge with which they are best acquainted This is not necessarily due to indolence nor to ignorance of the methods of research but is merely the result of peculiarity of temperament which lacks that divine curiosity which alone supplies the stimulus

I am speaking now only of real scientific research the inquiry into the secrets of nature not of the occupation of those who have only practical ends in view

Looking back over the great principles of natural science we see that in every case they have been established by the efforts of the amateur and by amateur I mean all who have undertaken the work for the pure love of it This includes not only men of independent position like Cavendish Lyell and Darwin but a large number of men who have held the office of professor or teacher but who in this country at any rate are neither paid to do such work nor required by the conditions of their appointments to undertake it So far as I know there is but one institution in this country in which the professors are not required to teach but only to press forward into the unknown and that is the Royal Institution in London But the character which that famous place has assumed during the last hundred years is not that with which it began its career It was started at the end of the eighteenth century by Count Rumford with purely utilitarian purposes in view namely for teaching the applications of new discoveries in science to the improvement of arts and manufactures and to facilitating the means of procuring the comforts and conveniences of life and while retaining that character and those pretensions it soon came to the verge of collapse But Davy's lectures and discoveries changed all that and Faraday's genius consecrated the laboratories for all time to the service of pure science

Let us review very briefly the great principles on which physical science is based

First of course there are the fundamental principles of the conservation of matter and of energy the latter finally established on a quantitative basis by Joule in 1843 There is the principle of uniformitarianism introduced into geology by Lyell now extended so as to include not only the phenomena of this earth but of the whole cosmos such extension being mainly due to the use of the spectroscope by Kirschoff and Bunsen and only a little later by Huggins The principle embodied in the so-called periodic law of the elements already referred to has led to a general belief in the evolution of matter from one primary material and physicists and chemists are vying with each other in the endeavor to gain evidence as to the details of the process I need scarcely say that the principle of evolution as applied to living beings is associated indissolubly with the names of Darwin and Wallace

Notwithstanding the discovery of radium and its allies and the discoveries by J J Thomson as to the disintegration of atoms into corpuscles a thousand or more times smaller all ordinary chemistry is built up on the conception of atoms introduced by John Dalton just a hundred years ago The consolidation of this theory has proceeded as a consequence of the discoveries begun in 1872 by Wislicenus developed by van t Hoff and Le Bel in 1874 and confirmed by an army of other workers down to the present day We now not only suppose it probable that atoms are placed within a molecule in definite positions relatively to one another but in a great many cases their order and arrangement in space can be positively traced

Suppose all these great laws and principles never to have been discovered—science and its applications would not exist and the world would have remained in about the same condition as it was in two hundred years ago Railways electric light and traction telegraphs dyes explosives antiseptics anæsthetics and many other drugs metals such as sodium aluminium magnesium tantalum and even modern steel would be unknown

But these things are merely the results of the recognition development and application of the principles already indicated as fundamental and the immediate corollaries from them And so it seems that there are two fields for research which are equally necessary to civilization and progress In the one the worker watches the operations of nature and puts questions in the form of experiments solely with the desire to find out her ways in the other attention is given only to those laws facts and phenomena which can be made serviceable to man There is much more public anxiety in regard to the last and considering how entirely ignorant are most people about the principles of physical and natural science this is not greatly to be wondered at

Some people are under the impression that there is an art of scientific discovery which can be communicated from one person to another That is not my belief I think the history of scientific discovery shows that each successful pioneer has invented methods for himself or has at least known how to select from the tools ready to his hand And with regard to personal qualifications I do not think it possible to create that combination of mental powers which is called insight Hence I have very grave doubts about the advisability of spending time and energy in trying to evoke and cultivate the capacity for research in all students in colleges and universities If this were possible we ought to see greater results in those cases in which it has already been tried The judicious teacher will of course be careful to avoid any appearance of indifference toward ardor and enthusiasm whenever they appear and he should ever be on the lookout for indications of the kind of capacity which alone repays cultivation and give it all the encouragement in his power But the clamor which has of late been raised as to the supposed desirability of extending instruction in the principles and methods of research, down to the very beginners, indicates to my mind a lack of judgment on the part of some of the agitators It seems to be forgotten that in every branch of experimental science and especially of applied science there is a great deal to learn and it is necessary that at the end of his career as a student a young man should be able to *do* things practically and usefully The theory of music and the laws of harmony are very desirable for the musician but if he is to be a performer he must devote the greater part of his time to practice on his instrument, whether piano or violin The case of the student of science is analogous and if he does not devote a good deal of time to learning the technic of his business he will not be ready for research or anything else At the present time too many students who can write at length on theoretical questions of a most recondite character and who boast that they have been engaged in research under eminent teachers, are yet incapable of choosing a subject for

* Presidential address delivered to the Vesey Club Sutton Coldfield England

themselves or of handling successfully a subject found for them by their teachers or someone else.

With the object of testing the influence exercised by methods of education in science on the development of the faculty of research I have lately had the curiosity to compare the results indicated by the lists of doctors of science of the University of London Up to 1886 this degree was awarded on the results of a very severe examination From 1887 onwards it has been obtainable only on the production of a thesis supposed to embody the ideas and the work of the candidate on some subject selected by himself The examiners are at liberty to impose an examination with the object of assuring themselves of the candidate s knowledge of his subject but as a matter of practice the examination has been reduced to a mere formality It was expected that this change of system would be followed by indications of much greater fertility in the fields of research Owing to the completeness with which chemical literature is indexed I have been able to make a comparison between the number and character of original papers published by the chemists in these two lists within the ten years following graduation in each case I have not been able to make so strict a comparison among the physicists owing to the distribution of their work through so many media of publication but I have been led by a careful survey to the same conclusions as in the case of chemists In both classes the *Examinees* and the *Researchers* if they may be so distinguished there are cases in which the doctor after taking his degree has done no original work—or at any rate none that was fit for publication—and his name does not appear in the literature of his science On the other hand both lists contain famous names I will only mention in passing that the names of Larmor and Lodge appear among the examined On the whole I see no indications that the procedure by thesis has had any effect whatever on the character of the graduates If anything the list of examined is of somewhat higher quality than the list of graduates by dissertation for there are nine out of fifty four who have become Fellows of the Royal Society while among the others there are only eight out of fifty nine who can write themselves F R S

In the latter list there may be one or two who may achieve this distinction hereafter but there are no indications that in the long run the amount and quality of the contributions made to science by the graduates who are supposed to have been trained to research will surpass those of the men who had to face the ordeal of examination

Does this not seem to justify my original contention that the researcher is born not a product of educational manufacture and that his disposition to research will survive all sorts of adverse conditions including those which are by some people supposed to be inherent in examination?

I feel convinced that most of the great discoveries of the future will be made as in the past by the inspired amateur working usually alone and often on apparently insignificant beginnings and with results which may not at first receive any attention from the world

It is however necessary in these days to provide for some form of co-operation in research partly for the reason that the cost of some kinds of investigation is quite beyond the means of most private persons and partly because of the unfortunate separation which still prevails chiefly in this country between science and industry

First then science may justly look for assistance from the State In England this is given in a grudging way Parliament allots £4 000 to the whole range of the physical and natural sciences The fund is administered by the Royal Society and the biggest slices out of it are taken in the form of contributions to the expenses of expeditions Then there is the National Physical Laboratory with an expenditure of about £25 000 a year of which £7 000 comes from the treasury This seems to be all that comes directly from the National purse but science is endowed to a certain extent by her friends This assistance is represented by the equipment of certain schools and colleges by the Guilds of London and by the small research funds of the Chemical Society and the British Association

Something more systematic is however wanted and I feel strongly that some of the rather large funds given in the form of scholarships to young students could be more advantageously used if applied to the maintenance of proved investigators to make them independent of the necessity to earn a living by teaching or other professional work I recognize however, the difficulties which would attend any such scheme In the first place discoveries cannot be made to order An able industrious, and conscientious man might work for many years without producing definite results and a few cases of that kind would destroy or shake public confidence. It would also be necessary to provide incomes large enough to retain the services of the most able men

With regard to the application of science to industry I think our manufacturers have made some progress during the last thirty years But they still suffer from delusions The mistake most commonly made arises out of a misapprehension of the methods powers and promises of science It still seems to be too often supposed that a scientific man called into hurried consultation can at once overcome a difficulty in a manufacturing process or can devise an improvement which if adopted would represent many thousands of pounds profit to someone If this were so scientific men would be better off than they usually are What is wanted is a general recognition of the principle that improvements can be expected only as the result of the use of scientific methods which are simply the methods of reason applied to the materials provided by experience

What every manufacturer wants is to begin with a scientific education if not for himself then for his sons or successors so that those who are at the head of affairs may understand fully the problems before them and in what direction to look for help towards improvement Failing this he will be dependent on the services of paid assistants and those services cannot be expected to produce the desired results unless they are paid for on a liberal scale In this country there has not hitherto been sufficient attraction to draw into the field of technology a due share of the best brains of the nation The prospect of ultimately reaching a salary of two or three hundred a year at the utmost is not sufficient to induce a young man of first rate ability to spend several years of his life and a thousand pounds or so of capital in scientific and technical studies and so the supply of the highest class of scientific assistance is at present far from what it ought to be

But suppose conditions to improve a question arises as to the best way of turning such assistance to account

A suggestion has lately been made that a new society should be formed to be constituted of trade committees associated with experts in various divisions of science to carry on experiments confidently in the interests of the manufacturers who become members of the society It seems to me that any suggestion is better than none if it results in the closer association of industry and science but I think this particular proposal would not be found to work in practice The requirements of different industries are too numerous and complicated to be met by an arrangement so simple for each committee would find itself occupied with so many different problems that nothing would be accomplished unless indeed the staff were very large In my judgment each manufacturer must endeavor to work out his own salvation Moreover the experience of the German manufacturer and to some extent also of the American shows that it can be done effectively The most famous example known to me is the case of the great Badische color works at Ludwigshafen on the Rhine There is a factory which employs some 5 000 men and which pays and has always paid 25 to 30 per cent or more on its ordinary capital The great feature of its organization is to be seen in the direct association of manufacture with research conducted by a staff of highly skilled scientific men

In England arrangements so complete are unknown and the number of highly qualified chemists and physicists employed in works 's very small I say nothing about engineers with whom I am not so well acquainted but the greater number of the chemists are merely testers doing routine work and because such men receiving the wages of a clerk have not been able to advance the industries with which they are connected their employers have in too many cases in the past come to the conclusion that science is of no use In the meantime many things have happened The neglect of organic chemistry in England forty years ago led to the complete removal of the coal tar dye industry to Germany where since that time has sprung up the equally important manufacture of synthetic drugs The saccharin the antipyrin the artificial perfumes consumed in England are not made here and it now looks as if the fixation of atmospheric nitrogen in the form of nitrate so important from the agricultural and industrial points of view was going to be taken possession of by Germany and America acting together England being left out

Such things have been said over and over again for the last thirty years or more and I am not aware that such statements have been shown to be fundamentally mistaken nor has there ever been any public explanation of the indifference displayed

The link between science and industry must be established by the masters of industry themselves I do not believe in the efficacy of much of the technical instruction which is talked about and I fear that much money is being wasted in the attempt to imitate industrial operations in schools and colleges What is wanted is the highest and most complete kind of instruction in pure science following a good general education conducted on such lines that the fittest only are passed forward to the university or scientific school Young people educated in this way form the material which should be utilized by the manufacturer But he must not expect that a man so prepared is going to earn his salary the first year or two He has got to learn his business and must have facilities for doing this or such talent as he has cannot be turned to account and this can only be done by taking him into the works This is a subject on which a great deal might and should be said but such a discussion is not suited to the present occasion

In conclusion I may perhaps be allowed to give a few minutes to a glance at the future—not that I can pretend to descry very much

We must remember that there is no finality in physical science The farther we go the wider does the horizon before us become but every discovery of a new fact or principle gives us a new instrument to help on to higher things Hence we may reasonably suppose that wonderful as the past has been the future will be more wonderful still

Here I will venture to draw a distinction between invention and discovery and to invention there is probably no limit It may be said to consist in making new combinations and permutations in the elements of knowledge already acquired Among the inventions which have affected the condition of man kind those which are concerned in locomotion stand first It may truly be said that life is lengthened not only by years but by opportunities and from this point of view quick traveling provided by steam and electricity is a great advantage It would be unwise to utter any predictions as to what may hereafter be done with big ships and aeroplanes only the old fashioned type of nervous system—already shrinking from the increased noise and bustle of the town —shudders at the thought that neither distant valley nor mountain top from the tropic to the pole can now be expected to provide an asylum where peace secure from intrusion is to be found

In Samuel Butler s Erewhon a remarkable book published about forty years ago a country was pictured in which moral delinquency was treated with sympathy and condolence while bodily disease of all kinds was held to be a crime and was punished by fine or imprisonment I suppose it will take a good many generations to reach that condition of enlightenment but the time cannot be far off when the propagation of infectious disease will in all civilized countries be abolished

The habitability of the planet Mars has of late been a subject of much revived discussion The possibility or probability of the existence of intelligent beings in other parts of the universe long a subject of debate is a question of profound interest but whether communication with them from the earth can ever be established who can tell?

But as to discovery in physical science as already said the horizon widens as we go on but it seems not improbable that there is a limit set though as yet very far off by the capacity of the human intellect Nature s ways used to be thought simple but now we know that she is not only mysterious but complex However there is every reason to expect that great strides are possible even in the immediate future The sort of problems which remain to be solved are represented by such questions as the following What is the cause and nature of gravitation and other sorts of attraction? What is the difference between positive and negative electricity and what is the relation of electricity to matter? What is the nature of chemical affinity and is it really electrical? What is the constitution of the elements and is the transmutation of metals a dream or a physical possibility?

The penetration into final causes seems as we proceed to be further and further out of our reach The problems of life and mind are up to the present inaccessible to man in his present state and notwithstanding the hopes and beliefs of some physiologists it is safe to say that they will remain so for a long time to come if not always

And even in regard to common matter and the physical forces all we know about them is derived from the perception of phenomena through the agency of our senses Now the senses sight hearing and the rest have been evolved not to provide the means of surveying nature but for the protection and advantage of the body to which they belong It is possible therefore that the human view of phenomena is only a partial and imperfect view at any rate the world which is open to the sense perception of a man must be very different from that which is perceived by many animals with their highly specialized senses such as the scent of the dog the sight of the carrier pigeon and perhaps other senses for which we have no name

In its ultimate nature said Herbert Spencer matter is as absolutely incomprehensible as space and time Whatever supposition we frame leaves us nothing but a choice between opposite absurdities.

The World's Daily Weather Maps

Systems Used in Various Countries

If you should wish to know just what the weather was doing on a particular morning at a particular spot on the land surface of the globe the chances are about two in five that you could satisfy your curiosity by visiting a meteorological library and consulting its files of daily weather maps

The accompanying diagram (Fig 1) shows approximately the area of the earth s surface that these maps now cover Nearly every civilized country including the larger European colonies now publishes at least one daily weather map based on telegraphic reports A few countries publish several maps i e maps are issued at several points within their respective territories Thus (including maps published in the daily newspapers) the United States Weather Bureau issues daily maps at about one hundred places in this country Germany publishes about twenty maps the most important of which is that issued at the Deutsche Seewarte in Hamburg India publishes three maps Most countries however issue a map at one place only viz the headquarters of the national weather service

The area represented by the map is not in most cases limited to a single country This is notably true in the case of the European maps the majority of which cover the whole of Europe The Egyptian map includes stations in Italy Greece Tripoli etc The maps of the United States Weather Bureau overlap with those of Canada

In point of workmanship the lithographic map published daily at Washington stands unrivaled while the handsome maps issued by Japan and Argentina compete for second place It would be invidious to specify the publications standing at the other end of the scale Suffice it to say that several extremely crude productions of this sort are issued abroad but in these cases the wonder is that they are issued at all considering the very meager funds and limited staffs the meteorological services in question have at their command

Besides the maps based on telegraphic reports and issued a few hours after the observations that they collate are taken there are several highly interesting synoptic maps the data for which are collected by a slower method and which generally appear months or even years after the date to which they refer The most notable publication of this character was a daily chart of the Northern Hemisphere published from 1877 to 1887 by the United States Signal Service —the predecessor of the Weather Bureau Several series of maps have been published for the North Atlantic Ocean and the adjacent continental areas

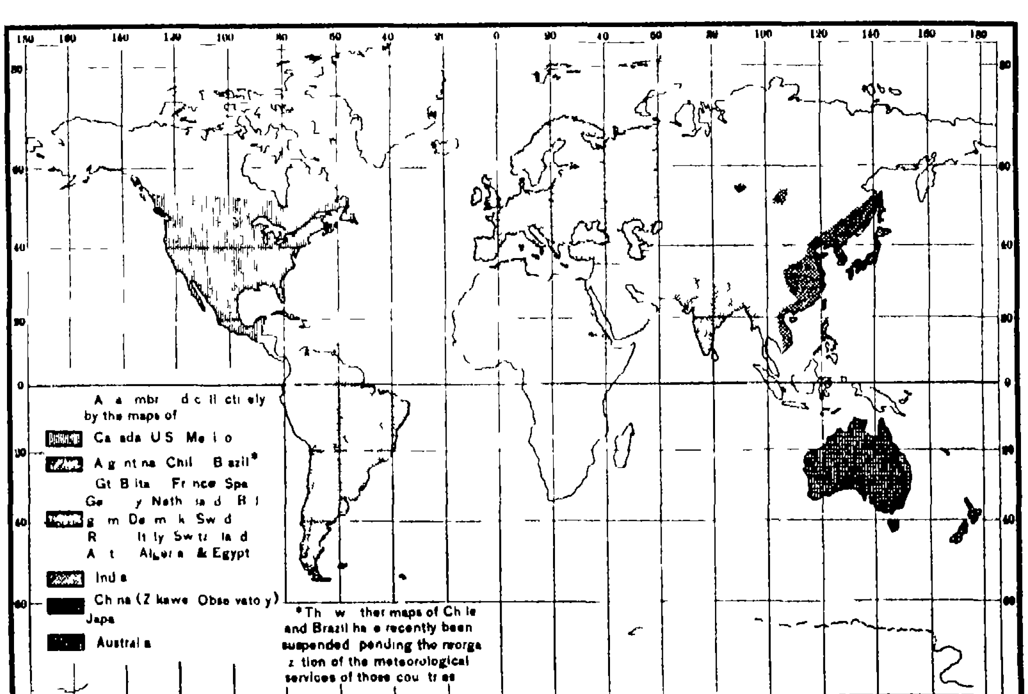


FIG 1—LAND AREAS EMBRACED IN THE DAILY WEATHER MAPS OF THE WORLD

Within a few hours after the time of observation weather maps based on telegraphic reports are published for the regions indicated by the shaded areas.

and two of these still appear viz the Cartes Synoptiques Journalières begun by Hoffmeyer in 1873, and now issued jointly by the Deutsche Seewarte and the Danish Meteorological Institute and the Internationaler Dekadenbericht published by the Deutsche Seewarte These maps of the ocean are based on the meteorological logs of vessels as well as the reports of land stations A specimen map from the Dekadenbericht is shown in Fig 2 This publication presents a somewhat sketchy picture of the weather over a wide area of land and water and appears with remarkable promptitude i e only a few weeks after the period to which it refers

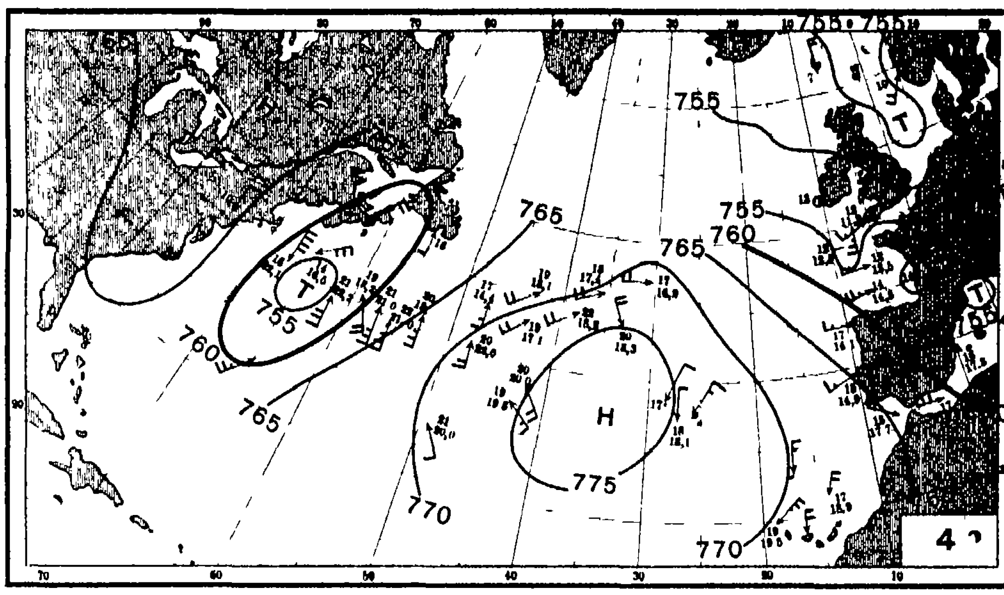


FIG 2—WEATHER MAP OF JUNE 4th 1910 8 A M

The point of the arrow shows where the observation was taken The arrow flies with the wind The tails of the arrow show the force of the wind on the half Beaufort scale The air temperature is shown in whole degrees (Centigrade) water temperature to tenths of a degree The curved lines are isobars or lines of equal barometric pressure Areas of high pressure are marked H (*hoch*) of low pressure T (*tief*) (From the Internationaler Dekadenbericht.)

The ordinary daily weather maps although primarily devoted to the weather prevailing over the land tend to spread out more and more over the adjacent oceans This expansion is made possible by the utilization of reports from islands—such as Iceland and the Azores—and to a limited extent of wireless reports from ships Observations of the latter class (i e wireless reports) are regularly shown on the English daily weather map but it must be admitted do not as yet add much to the value of the publication

In contrast to the European maps those published in the United States are based on strictly simultaneous observations They show the weather prevailing all over the country at 8 a. m Eastern Time In Europe the telegraphic observations are made partly on standard time and partly on local time and the hour of observation thus fails to coincide by two hours and more in extreme cases. However, in Western Europe including the British Isles the observations are nearly synchronous.

The problem of collecting the observations promptly enough for use on the charts, and in forecasting, has been a difficult one in all countries. It is solved most successfully in the United States, where the Weather Bureau is given priority by the telegraph companies at the time its reports are being despatched, and where the process is further facilitated by the use of an ingenious circuit system i e., the observations are assembled at a few points and at the same time are copied off at each station on a circuit as they pass over the wire this means a wonderfully rapid interchange of observations among the stations and enables the Bureau to publish its map simultaneously at many points throughout the United States In Europe national boundary lines—and the indisposition of the authorities in charge of the telegraph systems which are generally operated by the government to give special consideration to meteorological business—are serious obstacles to rapid transmission. In all countries the reports are sent in cipher A uniform code is used for this purpose in Europe

The history of daily telegraphic weather maps extends back about sixty years A few tentative undertakings of this kind were carried out both in Europe and America about 1850 but the first map that was destined to be a permanent enterprise was the French Bulletin Internationale" begun by Leverrier in 1863 and this has continued without interruption to the present day The continuous series of United States weather maps began with Professor Abbe s maps issued at Cincinnati in 1870 and soon after taken over by the Signal Service in Washington

The first published daily weather maps of the British Meteorological Office began in 1872

Proposed Department or Bureau of Public Health

The Secretary of Agriculture while in hearty accord with the general proposition to provide better facilities for work in the interest of the public health expresses himself as opposed to any plan which will remove from the Department of Agriculture the inspection work involved in the enforcement of the food and drugs act and the meat-inspection law to say nothing of certain plans which would take away the biological and entomological work of the Department. To remove from the Department of Agriculture the meat inspection and veterinary work, says the Secretary, 'would I believe be a great detriment to the work of this department and to the agricultural and live stock interests, without any corresponding gain in efficiency or advantage to the public, and would result in increased expenditures rather than in economy For example, the field work for the eradication of diseases of animals is carried on mostly during the summer, while the work of slaughterhouses is heaviest during the winter, and it is thus found to be practicable and economical to shift men from one to another of these branches as the needs of the service require.' The Secretary thinks it would be an expensive mistake to take away from the Department of Agriculture work which it is performing satisfactorily, and which it can perform better and more economically than any other agency

New Physical Apparatus*

Simple Instruments for the Laboratory

A VACUUM TUBE OSCILLOSCOPE.

Gehrke has shown that in a vacuum tube containing nitrogen the negative glow occupies a space exactly proportional to the strength of the electric current which produces it. Desselhorst has found that this luminosity is practically instantaneous, its beginning and ending coinciding exactly with the closing and opening of the circuit. The Berlin firm of Boas has constructed a vacuum tube oscilloscope which is very well adapted for the observation of the phenomena of currents of high frequency. The arrangement of apparatus is indicated in the first diagram (Fig 1). *A* represents the primary oscillatory circuit, in which the capacity is furnished by the Leyden jar C_1 and the self induction by the interchangeable coil P_1. A sparking coil can be bridged over the gap *F*. The secondary circuit shown at *B*, contains a variable capacity C_2 and an interchangeable inductance coil P_2. The secondary circuit is influenced more or less powerfully by the primary circuit, according to the distance between the coils P_1 and P_2. The character of the oscillation in either circuit can be studied by means

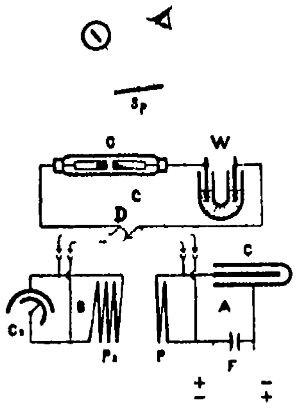


Fig 1

of the apparatus *C* which contains the vacuum tube *G* and which is bridged across either of the coils *P* and P_2 by means of the high tension commutator *D*. A water resistance *W* is connected in series with the vacuum tube in order to reduce the consumption of current. The tube *G* is observed by means of a two faced mirror *Sp* which is rotated by an electric motor at a speed which may attain 7 800 revolutions per minute. The observer sees in the rotating mirror two undulating lines of light the form of which correspond exactly to the momentary periodicity and general character of the electric current.

THE THEORY OF GRATING INVERSION

It appears from the experiments of Hertz that a grating formed of parallel wires is most transparent for electromagnetic waves when it is in the position shown at *A* in the second diagram (Fig 2) with the wires perpendicular to the electrical vector *E* of the waves, and parallel to the magnetic vector *M*. This phenomenon is known as the Hertz effect.

On the other hand the researches of Du Bois and Rubens appears to prove that a fine wire grating is most transparent for very short waves that is the waves of the visible spectrum when it is in the position *B* with the wires parallel to the electric and perpendicular to the magnetic vector. This phenomenon is called the Du Bois effect.

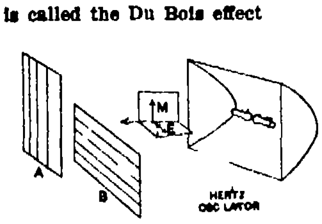


Fig 2

The wave length at which the Du Bois effect is replaced by the Hertz effect is called the point of inversion and is determined chiefly according to Du Bois, by the material of which the grating is composed. The results obtained by Du Bois however, are partly contradicted by the experiments of Braun who pulverized platinum wires on glass thus producing as he claimed exceedingly fine gratings which in all cases showed a well marked Hertz effect.

Schaefer and Reiche have published, in a recent number of the *Annalen der Physik*, the results of a theoretical investigation which indicate that Braun's observations were probably correct and that the Hertz effect is always produced when the diameter of the wires of the grating is small in comparison with the wave length. Hence it is desirable to repeat and extend the experiments of Du Bois and Rubens.

* Prometheus.

HIGH VOLTAGE INDICATOR

A simple method of determining whether a wire carries a current of high voltage or not consists in connecting the wire to earth through a Geissler tube in the manner indicated in Fig 3. The presence of a

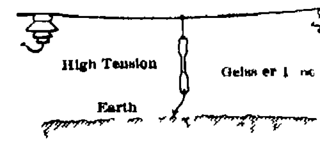


Fig 3

high voltage current is immediately indicated by the glowing of the rarefied gas in the tube. Owing to the high resistance of the vacuum tube no earth worth speaking of is produced by this method. A recent number of the *Elektrotechnische Zeitschrift* describes an indicator based on this principle and intended for stationary use. Fig 4 shows the indicator which is operated by turning up the handle *A* and thus placing the portion *B* which contains the Geissler tube in connection with the terminal *D* which is connected with the high tension circuit. The tube is observed through a little window at *C*. The axis of the movable arm and consequently the other end of the tube are connected with the earth. Fig 5 shows a similar apparatus devised for permanent use in which the tube is attached to the other parts by spring clamps.

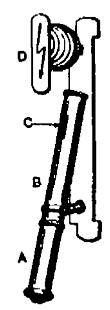


Fig 4

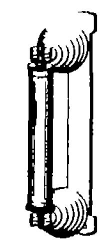


Fig 5

THE ROTAMETER

The accurate measurement of the velocity of flow of gases offers great difficulty in many experimental researches. A novel instrument for measuring this velocity has lately appeared in the market. The left hand (Fig 6) illustrates the principle of the apparatus which is called the rotameter. The gas flows upward through a slightly tapering glass tube *a*. The supply pipe is provided with a stop cock *c* and a cotton wool filter inclosed in a capsule *b*. The ascending stream of gas lifts a hollow indicator *e* to a height which varies with the velocity of the current and at the same time sets the indicator into rapid rotation about its vertical axis whence the name rotameter. The rotation prevents adhesion of the indicator to the wall of the tube. The flow in liters per second is given directly and very accurately by the portion of the indicator in respect to a scale etched on the glass tube. The scale is graduated empirically and a different scale is required for each gas.

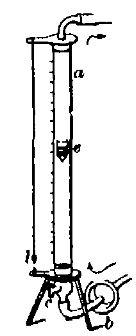


Fig 6

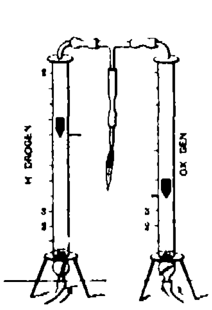


Fig 7

Two or more gases can be mixed in any desired proportions, easily and accurately with the aid of a corresponding number of rotameters. For example hydrogen and oxygen can be mixed in the proportions required to form water by joining the outlet pipes of two rotameters, the inlet pipes of which are connected with cylinders of compressed hydrogen and oxygen respectively and adjusting the stop cocks until the whirling indicators show that the flow of hydrogen is double that of oxygen. This arrangement of apparatus is illustrated by Fig 7.

THE KERR EFFECT IN GLASS

In 1875 Kerr discovered that double refraction is exhibited by dielectrics subjected by electric stress. The meaning of this statement is illustrated by the accompanying (Fig 8). A horizontal glass tube *a* the ends of which are closed by plane sheets of glass is filled with a transparent non-conducting liquid (carbon disulphide for example) in which two horizontal plates of metal *b* and *c* are immersed. By connecting these plates with the poles of an electric influence machine *d* or a galvanic battery of high electromotive force an electric field is created between the plates the lines of force running vertically in the direction of the arrows. In these conditions polarized light which traverses the tube lengthwise is found to move with different velocities according to the direction of the plane of polarization. In carbon disulphide for example light which is polarized in a vertical plane parallel to the lines of force travels more rapidly than light polarized in a horizontal plane. (The electric oscillations of light waves are perpendicular to the plane of polarization and are therefore horizontal

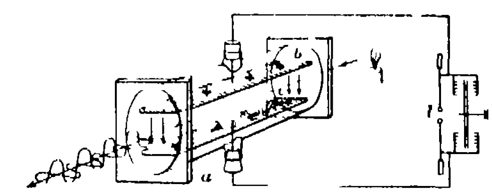


Fig 8

in the first case and vertical in the second.) As the index of refraction of a substance is the ratio of the velocity of light in that substance to the velocity of light in air we have here two indices of refraction and hence the phenomenon is called electric double refraction. The difference between the indices of refraction of light polarized respectively parallel and perpendicular to the lines of force when the fall of potential is one volt per centimeter is called the Kerr constant. The Kerr constant for carbon disulphide was measured in 1883 by Prof Quincke who obtained the value 32×10^{8}. A slightly different value 30.42×10^{8} has been found recently by Dr Tauern. An accurate knowledge of the Kerr constant is valuable as it enables high electrostatic potential differences to be measured by an optical method. Tauern's experiments have also confirmed the correctness of Kerr's observation of double refraction in glass subject to uniform electric stress. The value of the Kerr constant increases with the proportion of lead in the glass.

ELECTROMETER WITH VARIABLE RANGE AND SENSITIVENESS

Measurements with the galvanometer are made much more convenient by the possibility of diminishing the sensitiveness of the instrument ten fold one-hundredfold or one-thousandfold by the use of parallel circuits or shunts having resistances equal respectively to 1/9 1/99 or 1/999 the resistance of the galvanometer. Fig 10 shows how any given current

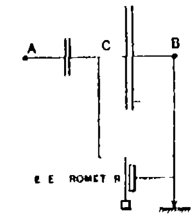


Fig 9

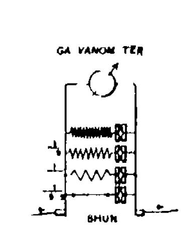


Fig 10

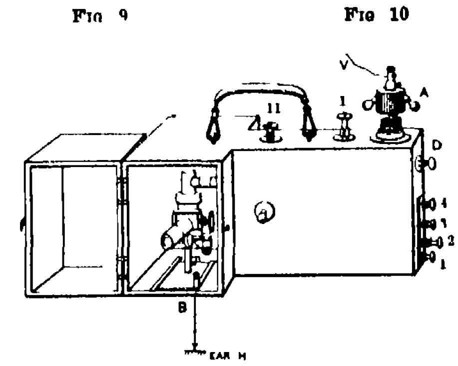


Fig 11

strength can thus be measured by means of a single galvanometer and a series of shunts

The need of a similar method of varying the sensitiveness of the electrometer is obvious Dieckmann has devised a portable inclosed electrometer which can be used with twenty one different grades of sensitiveness for measuring potentials from two volts to twenty five thousand volts (Fig 11) The principle of the apparatus is illustrated by the diagram (Fig 9) Let us suppose that it is required to measure the difference of potential between the points A and B Between these points two well insulating condensers free from residual charge are inserted in series The wire C connecting these two condensers possesses a potential which approximates more closely to that of the earth the greater the capacity of the condenser inserted between this wire and the earth, or the point B, compared with the capacity of the condenser between C and A Between the wire C and the earth is inserted the electrometer the capacity of the instrument itself being added to that of the condenser between C and B in estimating the degree of sensitiveness

Fig 11 shows a Lutz chord electrometer with microscope reading on the left and the above described potential reducer on the right The object whose potential V is to be measured is connected with the terminal A By means of the buttons I and II various condensers corresponding to that between A and C in Fig 9 can be inserted while the buttons 1 2 3 4 control the insertion of a number of other condensers, corresponding to that between C and B in Fig. 9 D is a button by means of which all parts of the interior of the apparatus with the exception of the terminal A can be simultaneously connected with the earth By drawing out the buttons in various combinations a great variety of grades of sensitiveness can be produced The condensers are all of cylindrical form and contain no dielectric except air As the Lutz electrometer does not require to be protected absolutely from vibration this apparatus can be used everywhere, even on overland journeys and on board ship, for the measurement of differences of potential ranging from two volts to twenty five thousand volts to within less than one per cent.

Illuminating Engineering*

Its Value to the Commercial Man

By William T Serrill

The writer has heard the opinion expressed that illuminating engineering is an abstruse technical science with only an indirect or remote bearing on practical questions and consequently that the commercial man of the electrical or gas interests can derive little of benefit from the study of this science or from attendance at the meetings of the Illuminating Engineering Society The object of this paper is to show that the opinion here described is erroneous

For the present purpose the subject may be divided into three classes namely First the design and development of lighting units secondly the determination of the light distribution and of other characteristics of the available units and thirdly the application of the available units to the spaces to be lighted as determined by the illumination requirements

It is evident that the commercial man is dependent upon the illuminating engineer for the design and development of the electric and gas lamps which he has available to offer to the public The physical and chemical principles underlying both of these forms of illuminants are abstruse and each has reached its present efficient form through invention and research on the part of scientific men The commercial man may well say It is not necessary for me to master these scientific principles I accept with thanks and put on the market the latest products of such invention if I am free to criticise and to state what my experience as a salesman indicates is required by the public and if the engineers meet these requirements I am satisfied

It may be admitted that the commercial man need not master the principles underlying the design of lighting units but the statement just put into his mouth shows how essential is a constant co-operation and exchange of opinion between the commercial man and the laboratory man The latter is to a large extent dependent upon the former for a knowledge of the public taste and of the extent to which the public purse will be opened to its gratification In addition the commercial man will understand the requirements demanded by the various kinds of buildings and of occupations as affecting such points as the size of the unit the distribution of light from it its color its daylight appearance etc The association together of these two classes of men at the sectional annual meetings of this society cannot fail to be of benefit to the art of illumination If on this point it may seem to the commercial man that he imparts more than he receives he should realize that it is in a good cause and will result in the production of more efficient units better adapted to the requirements of the consuming public

It is evident that the commercial man having at his command an assortment of lighting units in his effort to sell them must be possessed with a thorough knowledge of the salient characteristics of each of the units For this knowledge he is dependent upon the illuminating engineer The illuminating engineering laboratory with which the writer is connected has furnished or is now engaged in preparing information regarding the gas lamps that are being sold as follows

Light distribution curves of lamps and globes luminous efficiencies of lamps globes and mantles minimum distance from the ceiling it is safe to hang the lamps safe distance under awnings for outdoor lamps windproof qualities of outdoor lamps relative emission of radiant heat from gas and electric lamps relative intrinsic brilliancy of lamps fitted with assorted glassware proper heights of lamps of various types suitable for various purposes reflective efficiencies at various angles of various lights with standard wall papers absorption coefficients of glassware ignition devices color values of the light from various lamps strength of mantles adaptability of lamps to various gases and pressures loss of efficiency during service of lamps and mantles examination of lamp structure and suggestions for remedy of structural defects

Knowledge of the kind indicated in the above list is essential to the commercial man in his effort to sell and to meet the competition of other forms of illuminants Here there is reached another point which emphasizes the importance of the commercial man attending the metings of the Illuminating Engineering Society At the meetings he learns how to interpret and utilize the data furnished by the laboratories The subjects contained in the above list are of the sort that are considered and discussed at the meetings Any salesman listening to and taking part in the discussions thereby improves his efficiency by increasing his knowledge of the thing he sells

Having considered the laboratory end of illuminating engineering and having shown the value to the commercial man of his participation in the discussion of subjects connected with that branch it is well now to approach the third division that of applied illuminating engineering

In considering this subject one is met at the outset by the startling fact that the application of lighting units to interiors is and from the nature of conditions must be made by the commercial man In any city the electric light company and the gas company through their canvassing departments handle such work There is to be sure the consulting illuminating engineer who may plan a fraction of it but it remains true that the great bulk of lighting installation work is carried on by the gas and electric interests In the stress of competition these interests actively canvass and thus secure the work

Now canvassing for light is like other canvassing essentially commercial work It is organized and carried on for a direct and immediate commercial purpose and it must be directed by a commercial head The atmosphere of a department where canvassing is carried on should be charged with the commercial spirit Engineering departments from the nature of their duties do not develop among their employees the selling instinct The writer does not mean to imply that an engineering education is not helpful to a salesman or to any one in charge of a selling department The point he wishes here to make is that a canvassing department to be successful should be organized as such and should devote its energies exclusively to that purpose

In canvassing for light the conditions are such that generally the character of the installation must be determined by the canvasser during his visit to the consumer's premises and frequently in the consumer's presence The stress of competition and the sensibilities of the consumer generally combine to make the element of time an all important factor The prospective customer says "Here is an interior Can you light it satisfactorily? Can you improve on its present lighting? How much money can we save by installing your system?" In order to secure the work at all the canvasser must be prepared to give an immediate answer to these questions, and, in so doing he is determining the character of the installation his company will make in case it gets the order In other words the canvasser is doing the applied illuminating engineering The fact that the orders so taken may be given to an engineering department to install, and that in this way the plans of the canvasser may be checked, and corrected if mistaken, is not to the point. Occasionally such a change might be made, but many cases of this kind would seriously affect the business

Having shown that practical considerations force the application of lighting units to interiors into the hands of the canvasser it should be unnecessary to furnish an additional argument toward the education of the canvasser in the principles of illumination Each company must solve for itself the problem of imparting this education upon its success will depend whether or not the interiors covered by its field of operations are properly lighted In the writer's opinion the Illuminating Engineering Society should become an active factor in the education of the lighting canvasser Especially should the local sections take an active part In these more time should be given to discussions of actual installations Such installations illustrated by diagram or photographic slide when criticised and discussed in public meeting have a high educational value Commercial men members of local sections should be encouraged to present descriptions of such installations and of interesting problems that arise in their experience

The Illuminating Engineering Society has been adversely criticised for devoting its energies too exclusively to the abstract chemical physical and physiological problems that pertain to the profession Even if the charge be true the adverse criticism is not deserved The profession of illuminating engineering is emerging from the state of infancy It is proper that the scientific principles which underlie the profession should have been mastered before the more practical phases of the subject come to the fore The society is now in position to devote more time to the latter It has been suggested that the annual sessions should consume four days two being devoted to the scientific and two to the practical branches of the profession The purely commercial phases of the sale and introduction of lamps should probably not be considered by this society

At this point some commercial man arises and protests somewhat as follows The practice of illumination is an art and the main qualification of the person who practices this art is experience combined with common sense It may be true that the art is based on scientific principles more or less abstruse but a knowledge of these principles is not essential any more than in the art of preparing food the expert cook must be acquainted with the chemical and physical changes brought about by the application of heat to animal and vegetable tissue I grant my man must be thoroughly familiar with the lighting units and the accompanying glassware and must be able to interpret the light distribution curves and other data furnished by the laboratories but when it comes to the actual application of the units to the space to be lighted judgment based on experience is the only tool he needs There may be some cases of such complication that he may need the advice of an expert illuminating engineer but they are few and far between Practical conditions in most cases prevent an ideal arrangement of the lamp these practical conditions are so numerous and so compelling as to become the dominant factors, so that the best illumination obtainable is a compromise Outlets are fixed, and it is expensive or inexpensive to change them, the ceilings are low, columns, showcases, balconies, etc. interfere these and numerous other practical consideration are such that, in the great majority of cases, the installation made by the consulting illuminating engineer, after calculating the illumination at all parts of the room, will be identical with that made by an experienced man, using nothing but his judgment as a guide."

The above remarks of our commercial friends are interesting, and contain considerable of truth, but there is in them no argument against the proposal to educate the lighting canvasser in the principles that underlie practical illumination. No one can argue that a knowledge of these principles will detract from

* A paper presented at the Fourth Annual Convention of the Illuminating Engineering Society, Baltimore, October 24th and 25th, 1910

this man's efficiency, very few will have the temerity to argue that such a knowledge will not be of positive value to him

The practice of illumination is indeed an art, but is it not also something more namely a profession? Those arts in which the processes are so simple that no knowledge of the underlying principles is needed in order to practise them are arts pure and simple In proportion as the processes become complex and involved and as the problems contain many variable quantities a knowledge of these principles becomes essential and the art merges into a profession Shining shoes and washing clothes are arts in which the processes are simple requiring on the part of the boot black and washer woman no knowledge of the chemical and physical changes involved Cooking is to a certain extent such an art but the frequently urged claim that it is practically a lost art is due to the fact that most of the cooks are 'practical cooks and that too little attention is paid to a knowledge of the underlying principles The more complex the problems involved in illumination the more numerous the practical obstacles the more essential becomes a knowledge of and a constant reference to the principles which underlie the profession of illuminating engineering

A word of re-assurance may here be advisable lest the commercial man be frightened at the vast extent of learning that is expected of him The transactions of this society as one turns them over page by page present many formidable propositions to any one who is not a trained scientist or an expert mathematician The commercial man may be comfortable in the thought that these are not for him The principles he needs are relatively simple, and such as he can easily grasp if he appreciates their importance and seriously applies himself to them He should learn how to determine the amount of illumination from the curve of the lighting unit when the units are spaced at any given distance and height and how to allow for the effects of reflection from walls and ceiling He should maintain a drawing board for his own use and should use it constantly never guessing at the result when it may be ascertained by proper calculation Most formulas that he needs in his work are given in table form for his convenience and constants are provided for his use it is not absolutely necessary that he should understand the derivation of the formulas or the laws on which the constants are based but the more he understands of them the better He should practise to think and judge of illumination in definite units—in foot-candles and to enable him to do this he should understand the use of the portable illuminometer and make constant use of this instrument in reading the actual illumination obtained by the equipments he installs There is no better way to train the judgment than this constant checking of calculations by results He should be a constant attendant at the meetings of one of the local sections of this society even although he may not follow every argument or calculation he will surely absorb from every discussion some grain of knowledge which will enable him more intelligently to meet the demands of his calling

The profession of illuminating engineering deals with an important subject fraught with grave consequences to the future of our race Conserving the most vital one of those five senses which form the connecting links between the personality of the individual and the physical world it is destined to exercise an important influence on the progress of civilization It enlists the services of the physicist the chemist the mathematician the physiologist the oculist the manufacturer the architect the artist and in this list the commercial man holds an honorable and commanding position No one two or three of the types of men here named can solve the multifarious problems of the profession It requires the services and the co-operation of them all The profession cannot afford to have any one of them hold aloof and it will prosper in proportion to the degree of co-operation and of interchange of opinion that is maintained and to the extent to which those individuals who compose each group endeavor to broaden their views by obtaining as great a knowledge as possible of the activities of the other groups The commercial man cannot afford to remain ignorant of the progress of illuminating engineering The best basis upon which to build the knowledge and experience of salesmanship in this commodity is a familiarity with the principles of illuminating engineering

Correspondence

The Star Clusters

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT

The suggestion of Mr Arthur K Bartlett in the SUPPLEMENT of the SCIENTIFIC AMERICAN of February 4th that the solar system is gravitating toward the star-cluster in the constellation of Hercules is perhaps worthy of more attention than on a superficial view is accorded to it The problem what are the laws of motion of a system of bodies subject to mutual attraction according to the law of gravitation or any other law cannot be solved by the mathematical methods which are available at present In other words the algebraic equations which define these laws cannot be obtained Even the solution with regard to two bodies is only a partial one since it rests on the hypothesis that the original tangential impulses took place in the same plane which is infinitely improbable If this solution has been attempted and accomplished on the hypothesis that the directions of these impulses crossed without intersecting one another it has not come to the writer's notice

Although we cannot solve the general problem yet according to the laws of mechanics certain principles have been established which can give us some idea of the manner of motion of the bodies under consideration These are

1 The center of gravity of a system of bodies subject to mutual attraction is stationary with regard to those bodies just as the sun is stationary with regard to the planets

2 The sum of the areas described by the radii vectores each multiplied by the respective masses of the moving bodies is constant

3 The vis viva of the system is constant

From the last principle it follows that the system can never come at rest

The second principle establishes the fact that the nearer the bodies approach one another the greater must be the velocity of their motion

The first principle necessitates that all the bodies must gravitate toward one and the same point namely toward the common center of gravity

When several thousands of bodies in their course gravitate toward one point, it would seem that at some time or other in the neighborhood of that point a cluster will be formed Granting this let us try to determine what course any one of the bodies under consideration is likely to follow

Suppose a body is moving away from the cluster then the attraction of the cluster will retard and finally reverse its motion

If at this juncture the body is affected by no tangential force in other words if it has been moving in a straight line which passes through the common center of gravity then it will return along the same line approaching the cluster with increasing velocity and finally reaching it The universe is built on so generous a plan that the body here considered may traverse the cluster without coming in collision with any of the bodies composing it no more than a comet passing through the solar system must necessarily collide with any of the planets or satellites of that system Indeed the fact that the stars which constitute a cluster can be observed individually and counted shows that the distances which separate them must be very considerable Moving as it does in a line which passes through the common center of gravity the attractive forces which affect the body in a direction perpendicular to that in which it moves will nearly balance each other So it must continue to move in a straight line passing through the cluster and then departing from it with a velocity which is retarted continually until it is exhausted and the motion of the body is reversed once more Such a body therefore will simply oscillate between two points on opposite sides of the cluster and equidistant from it

If the body which is the subject of our consideration at the time when its motion is reversed was moving in a direction which did not pass through the common center of gravity then it will describe approximately an elliptical arc and in returning it may or may not traverse the cluster

If the body does not traverse the cluster but passes by it then the cluster will operate upon it as the sun does on a comet that is swing it around and throw it back into space and the orbit of that body will be approximately a more or less elongate ellipse of which the common center of gravity will be one of the foci

If the body does traverse the cluster it will be affected by the attraction of that part of the cluster which is bounded by a sphere whose center is the common center of gravity and of whose surface the moving body is one of the points The attractive forces which the bodies outside of that sphere exert on the body under consideration will nearly neutralize each other Virtually the conditions which determine the motion of the body here considered will be the same as those which govern the motion of a body that does not enter the cluster The orbit of every body therefore that traverses the cluster and does not pass through the common center of gravity will likewise be approximately a more or less elongate ellipse having the common center of gravity for one of its foci

As to the motion of the bodies composing the cluster each body of the system in its turn will approach the common center of gravity and the cluster therefore is composed of those bodies which temporarily are in the neighborhood of that center

Of course all these conclusions are very rude approximations and the orbits of a stellar system are not pure ellipses no more than are the orbits of the planets satellites and comets of our solar system Yet it would seem that the theory here presented gives a fair idea of the interaction of a large number of bodies subject to mutual attraction Perhaps the best example of the probable motion of the bodies of a stellar system is afforded by the comets which appertain to the solar system

Although the passage of a body appertaining to a stellar system through the central cluster of that system does not necessarily involve collision with other bodies yet it does not follow that such collision does not occur from time to time On the contrary occasional collisions are not only probable but apparently necessary for the preservation of the caloric energy of the system

Perhaps every star cluster is the center of a stellar system and the furnace in which the bodies belonging to the system regain the heat which they have lost during their long excursions in space

Pella Iowa JOHN NOLLEN

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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1859, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., 361 Broadway, New York.

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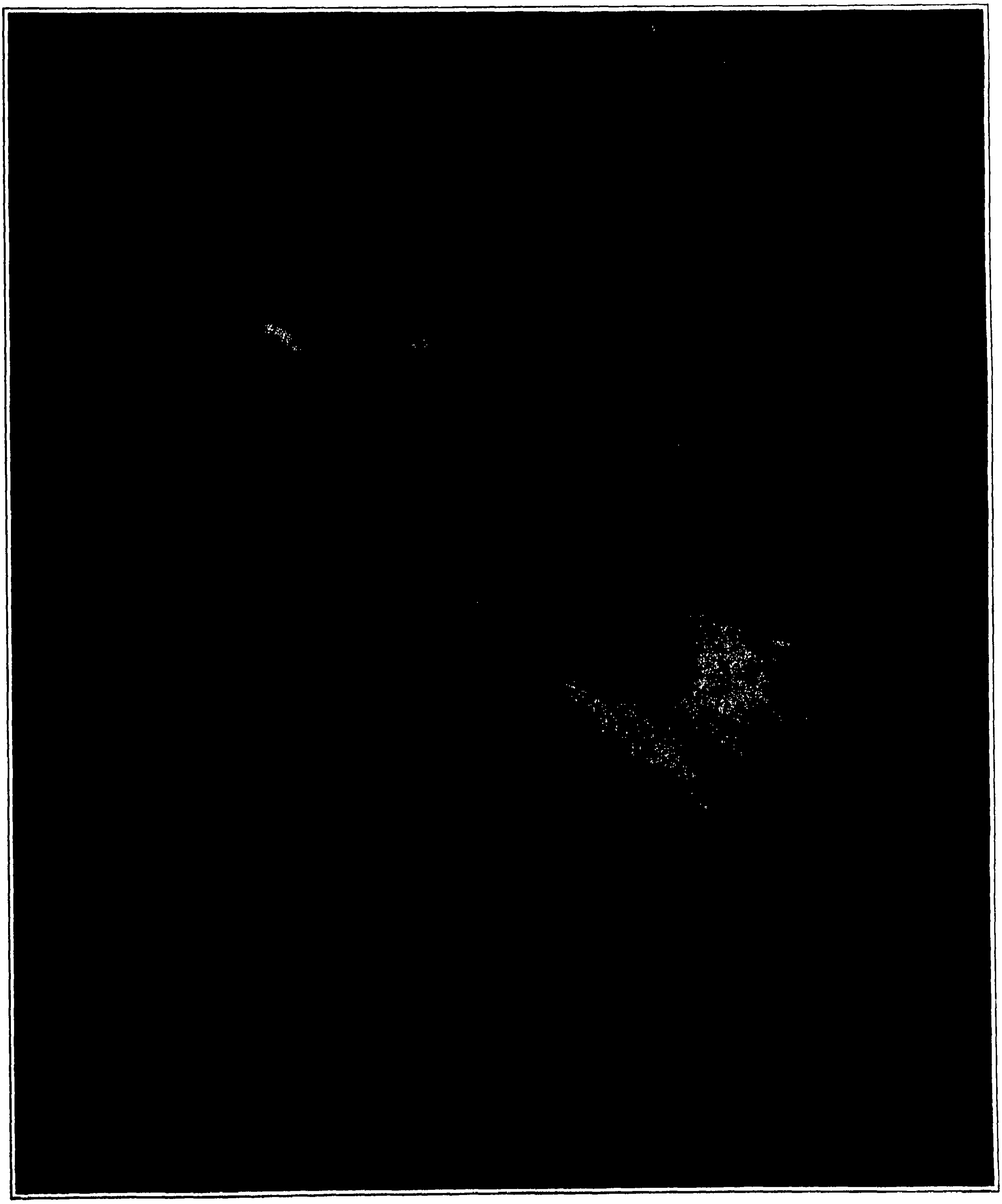


A NESTING CRANE IN THE ZOOLOGICAL PARK. THIS SPECIMEN IS SO SAVAGE THAT A KEEPER MUST CONTINUALLY BE ON GUARD AGAINST ITS POWERFUL BEAK

THE CRANE COLLECTION OF THE NEW YORK ZOOLOGICAL PARK.—[See Page 200]

Handling Passengers on a Rapid Transit Railroad—II*

Construction of a Rapid Transit Line as Illustrated by the Hudson and Manhattan Railroad

By J Vipond Davies

Concluded from Supplement No 1838, page 179

It is not possible in all cases to load passengers so that they will be evenly distributed throughout the train as is the case at Church Street terminal For instance at Hoboken terminal the only connection available for interchange of passengers with the Lackawanna Railroad enter the first car they come to and fill the cars at one end of a train leaving the cars at the other end practically empty To counteract this unequal train loading an entrance for passengers interchanged with the Public Service Corporation (trolley cars) was constructed as near as possible to the other end of the station and the result is a well balanced arrangement for the distribution of passengers through out the entire train Similarly at the Pennsylvania station passengers from the railroad are necessarily delivered to the Hudson and Manhattan Railroad at the extreme easterly end of the station and to counterbalance this entrances for passengers from the trolley cars and street are located at the westerly end of the station The local stations on Sixth Avenue have all been arranged with entrances and exits as near as possible to the center of the train whereas the stations at Christopher Street and Ninth Street owing to curves in the line which prevented the platform from being centered on the only available site for a stairway and entrance are arranged for end loading—Christopher Street at the westerly end and Ninth Street at the easterly

In the design and construction of the stations of the New York rapid transit subway practically all the entrances and exits consist of openings in the side walks covered by kiosks which interfere seriously with the use of the sidewalk In the development of the Hudson and Manhattan lines the Rapid Transit Commission appreciated the objections to the kiosks erected on the sidewalks and compelled the company to arrange for the entrances and exits through private property unless specifically permitted to do otherwise by the Commission In some cases arrangements were made for entrance and exit through private property on Sixth Avenue and in other cases entrances and exits were placed under the stairways leading to the elevated railway so that the erection of kiosks involved no additional obstruction on the sidewalk To make a railroad of the greatest convenience to the traveling public the stations need be clearly defined and easy of access An entrance through private property seldom affords the same convenience to the public as does an entrance direct from the public streets even at the expense of obstructions such as railings or kiosks Entrances placed directly upon the street are more in evidence and are consequently of greater value to the public so that although at first thought the obstruction to the sidewalk may be considered as pre eminent yet the general convenience of the traveling public is better served by kiosks On the other hand where it is possible to arrange stairways as was done on the Hudson and Manhattan Railroad under the stairs of the eleated railway so as to provide this convenience without additional obstruction to the sidewalks the arrangement is ideal There is however one serious drawback as in the majority of cases the stairways to the elevated railway are so narrow as to give inadequate width for proper service and wherever there is a possibility of passengers moving in opposite directions no stairway should be installed less than five feet in width and it is desirable to make them not less than six feet wide which allows ample width for two persons abreast walking in the direction of the maximum movement and one person in the direction of contrary movement The interference with the movement of passengers in the maximum direction by an opposite movement on narrow staircases is detrimental to general efficiency

Platforms should be designed to provide ample room for the free movement of passengers In the case of unloading platforms all that is necessary is to have sufficient space with ample exits so that an entire trainload of people can be easily discharged onto the platform within the limit of time fixed for the station stop and further that the entire trainload so discharged may pass out of the station before the arrival of the following train It is usually not necessary for a platform to be wider than the floor area of the car itself although there should be a widening of platforms in the vicinity of stairways or exits as there must of necessity occur a slight congestion at the points of exit from the unloading platform In the case of loading platforms the consideration is affected materially by the character of train service operated With the Hudson and Manhattan Railroad at Church Street terminal and later at the Thirty third Street terminal there are in use platforms twenty feet wide common to trains serving different routes There must therefore be ample room on the platforms for an entire trainload of people to stand for either route for which a train is destined and to distribute them selves so that they can enter the train immediately upon its arrival It is obvious that if an attempt is made to unload passengers from an arriving train onto the same platform on which passengers waiting to leave on the same train are standing the movement of passengers is seriously interfered with and the public inconvenienced since the station stop must be increased to permit loading and unloading of the trains It is very plain therefore without argument or the use of figures that the convenience of the public and the rapidity of passenger movement can be best accomplished by unloading passengers onto one platform and loading them from another It is quite material in unloading passengers that the train stands on a tangent The great objection to a train standing on a curve at a station is that passengers may be injured by stepping through the gap between the train platform and the station platform In the Rapid Transit Subway in New York as well as elsewhere this gap has been illuminated by lights underneath the edge of the platform which clearly indicate the gap and assist materially in avoiding accidents but apart from the possibility of accidents the location of a station platform on a curve with the consequent gap between the platform of the car and the station platform seriously affects the rapidity of movement of passengers either entering or leaving the train There is an instinctive pause by each individual seeing the gap the movement is much slower in consequence and the length of the station stop is materially lengthened

The arrangement of ticket offices is important in station design At first sight this seems like a matter requiring little attention but as a matter of fact it is essential in the economical operation of a rapid transit railroad and in the efficient handling of passengers. In arranging ticket offices it is vitally important to locate them so as to force passengers as far as possible to move in the right hand direction and it is also important to arrange the position and grouping of the ticket offices so that the line of passengers purchasing tickets will not be interfered with or crossed by passengers leaving the station or by those with tickets desirous of reaching the trains. Ticket offices for the sale of steam railroad tickets should be located in convenient sight of travelers but entirely out of the stream of traffic whereas for the sale of strip tickets used in rapid transit service the boxes must be located along the direct stream of movement, so that no passenger leaves his general direction and yet so grouped that while one stream of persons is purchasing tickets there is unobstructed opportunity for those persons already having tickets to pass along The arrangement of ticket windows in tandem on the same face is valueless, for the reason that those who are buying tickets at the first window must of necessity cross the stream of passengers trying to obtain tickets at the second window which invariably causes discomfort and obstruction. The Hudson and Manhattan Railroad has carried out the usual arrangement of installing one large and important ticket office at a station in which the ticket agent can keep his safe, stock of tickets and cash and in addition has provided sundry portable ticket offices which can be wheeled into line during the busy hours and moved entirely out of the way during the slack hours In all cases the arrangement of ticket offices should be such that the ticket-chopper is near to the ticket seller so that the seller may have the chopper under observation, and so that in case of necessity the ticket-chopper may assist the ticket-seller However, the distance between the two should be such as to permit a passenger, after having purchased a ticket, to pause before putting the ticket into the chopping box. One ticket-chopper usually serves two lines or streams of traffic, and the barriers should be only so wide as to allow a single file of passengers to pass on each side of the chopping box. The most convenient and desirable width for this passage is 24 inches With the ordinary stream of passengers on this road it is found that one ticket-chopper can pass through the gate in two files 108 passengers per minute. This rate of passage is too great however, except for short spurts as the chopper cannot properly examine tickets, and provision should be made for an average rate per chopper not exceeding 4 000 persons per hour An examiner who has to punch or personally scrutinise railroad tickets can only pass about 30 per minute An ordinarily competent ticket agent will sell about 2 000 rapid transit tickets per hour and make change, or for short periods may sell as many as 2,500 tickets per hour In calculating the number of selling agents or chopping boxes necessary for handling the maximum traffic these figures can be taken as a basis for speed

In connection with the stations there is one other matter to which reference should be made that is the necessity for the use of elevators or escalators at certain points in the underground railroad where the depth of the station below the surface is considerable The new plans of the Public Service Commission require them when the lift exceeds 30 feet. This is provided on the Hudson and Manhattan Railroad at the Pennsylvania station in Jersey City The capacity of an escalator is usually thought to be considerably greater than the capacity of an elevator on account of an escalator taking a continuous stream of people and moving them as they arrive without an intermission or pause which is of considerable importance as a pause however short in duration affects materially the flow of passenger movement The elevator service was installed at the Pennsylania station therefore on account of the absolute necessities of the case as it was impossible by any arrangement which could be devised to lay out an escalator service at that point and the conditions were ideal for the installation of an elevator service The company provided elevator service with the utmost appreciation of the possible congestion arising therefrom The size of the elevators was limited by the width of panel in the main bracing of the elevated station and allowed cages only 10 feet square Further the Pennsylvania Rail road Company could not without seriously affecting its own business spare the concourse floor room sufficient for more than four elevators The capacity of these elevators on the basis of allowing two square feet per person is fifty persons per lift, and as the lift of about 92 feet is continuous from bottom to top and *vice versa* it was agreed to operate at the comparatively slow speed of 300 feet per minute particularly as the actual running time of the elevators is small when compared with the total elevator interval. To facilitate the movement of passengers the scheme of dividing incoming and outgoing passengers, was used, the same as in the other stations This was done by providing openings on the front and rear of the elevator cages, receiving passengers from the Pennsylvania Railroad trains direct into the elevators from the train side and discharging passengers from the tunnels to the Pennsylvania Railroad trains on the opposite side. The gates are as nearly the full width of the elevators themselves as they could be made. It was possible to get an effective gate opening of 6 feet 3½ inches in width and to equip the elevators with a pneumatic device by which the elevator operator controls the opening and closing of the doors of the cages and elevator fronts. The result of the layout has thus far greatly exceeded the original idea of its possibilities and has more than satisfied the officers of the Pennsylvania Railroad as to capacity It is usually not desirable to attempt to fill the cages to their maximum capacity and to handle passengers most efficiently and expeditiously it is found that a load of forty persons will accomplish more than one of fifty, on account of the delay in loading the additional ten people. In this manner, the four elevators can handle passengers at the rate of sixty people per minute in one direction. On one occasion five fully loaded suburban trains of the Pennsylvania Railroad, after being stalled at Point of Rocks outside Jersey City, came into the station practically in a procession, and the passengers moved into the elevators as they arrived without the slightest congestion or undue inconvenience. An elevator of the size installed at this station is probably more efficient for the rapid handling of passengers than one of large floor space, as the service is so rapid that there is practically no pause in the flow of people.

Cars—In handling passengers, the second important point is the design of car, particularly with reference to loading and unloading, and its internal arrangement as affecting the passenger and its relation to the

* Proceedings of the Engineers Club of Philadelphia.

station. In the first place, the train service operated by the Hudson and Manhattan Railroad is essentially a short-distance service The longest continuous distance usually traveled by a passenger—from Pennsylvania station to Thirty third Street, or from Hoboken terminal to Church Street terminal—is less than four miles, consequently the time a passenger is in a car is comparatively short, and not comparable with the time taken on a railroad such as the electrified lines of the Long Island Railroad or the Interborough Rapid Transit Subway where a passenger may ride from 20 to 25 miles on a continuous trip It is a well known fact that a crowd of people desirous of traveling on a train will insist on using the first train in every case and will jam itself into a train whether there is sitting room or not notwithstanding that another train is following within ninety seconds and in spite of the fact that crowding an already overloaded train materially lengthens the time of the station stops and interferes with the headway and progress of all following trains The next following train may be running practically empty It is therefore not essential on a road such as the Hudson and Manhattan to attempt to provide the maximum seating capacity in a car but it is necessary to give the maximum seating capacity only under ordinary conditions and at ordinary hours and to give the greatest floor space for standing room and for carrying the maximum number of people in the easiest way with the least obstruction and inconvenience due to deliberate overcrowding

The Hudson and Manhattan Railroad trains are essentially moving terminals for the steam railroads a very large number of passengers carry valises and other baggage consequently the car with the greatest unobstructed floor area is the most advantageous for such service For this reason it is desirable to arrange the seats along the sides of the car without cross seats which possibly would have given but four or six seats additional per car but which would have obstructed very materially the rapid movement of passengers This arrangement gives a seating capacity of forty four persons per car A novel feature of this scheme for seating is the subdivision of seats into sections which was devised by Mr Stillwell This scheme was adopted because most of the passengers desire corner seats and for the purpose of stiffening the side trusses of the car The subdivision of seats into sections is convenient and has proved to be very popular

The use of the enameled rods in place of straps adds another convenience for passengers Enameled rods are more sanitary than leather straps and a new enameled metal loop is being tried by the Rapid Transit Subway as a substitute for leather straps.

The newspapers have so thoroughly educated the public as to the merits and demerits of side doors for cars that there is little to add here Side doors were first used in a practical way on the Hudson and Manhattan road and with complete success but to get the maximum efficiency they should be used in conjunction with platforms at the level of the car floor and with station platforms arranged for loading passengers on one side and unloading on the opposite side The cars have a clear opening of 36 inches for each end door and 41 inches for the side door With these conditions 106 people can be unloaded in twenty nine seconds or at the rate of 3 65 per second and there is not the necessity for the very wide doors which are essential where the loading and unloading is from the same side The earlier cars of the Rapid Transit Subway were arranged with only end doors having an effective opening of about 33 inches This is wider than is strictly necessary for a single line of passengers but at the same time altogether too narrow for a double line Cars more recently built and provided with side doors have an effective opening of 47 inches which permits a double line of persons outward or a single line of passengers moving out and a single line moving in at the same time but even with these wide openings the result is not as expeditious as with loading and unloading on opposite sides

The installation and operation of side doors is complicated in opening and closing as the side doors are necessarily out of sight of the guards standing at the end of the car and the doors cannot conveniently be opened and closed by men on the platform It would be a very serious burden to maintain men on every platform to operate the side doors On the Hudson and Manhattan Railroad all car doors are equipped with a pneumatic device for opening and closing and there are air-cushions on the edges of the doors No trouble whatsoever in the operation of the doors and practically no accidents of a serious nature have occurred The Rapid Transit Subway has equipped the side doors of its newer cars with mechanical devices operating with a chain and toothed gears which appear to operate satisfactorily

Generally speaking in rapid transit service the conditions are different from street railroad conditions by reason of the fact that on a street railroad passengers get on and off the cars and trains anywhere and that fares are collected in each car at the point where a passenger gets on which makes the entire distance the car travels practically a continuous station In any rapid transit or high speed line it is necessary to make definite stops at stations and to equip each station properly for the sale and collection of tickets instead of on the trains

The greatest complication in connection with a moving platform device is in making it a continuous station One of the points of advantage in a moving platform is the fact that the whole distance can be made a station practically the condition on a street railway but it is almost impossible to equip the whole length of the platform with ticket agents

The capacity of trains is regulated as before outlined by the capacity of the cars forming the trains The frequency is regulated by the time interval at which trains can be operated and is irrespective of the speed of trains which affects only the convenience of the public and the ability of a railroad to get business A railroad is a commercial enterprise and while it is constructed for public service it is primarily constructed with a view of obtaining an adequate return on the money invested To obtain this result therefore on a private or public investment it is essential to operate with the greatest efficiency and to so design a railroad that it can give maximum service

Therefore the details presented here will indicate the importance of not sparing trouble or expense in designing constructing and equipping a railroad so as to give the greatest service with the least inconvenience to the traveling public combined with maximum efficiency and economical operation The essential point with a public service corporation is to serve the public properly and this was the underlying thought of Mr McAdoo the president when at the opening of the Hudson and Manhattan Railroad he addressed the employes with words to the effect that he wanted no effort spared in the operation of the railroad to please the public

If it is conceded that a rapid transit railroad is a public utility then there is also implied a mutual obligation between those who operate the road and the public authorities who grant franchises and regulate the service to treat each other in a broad minded manner and to co operate in providing rapid transit facilities which will be of the greatest service and convenience to the traveling public

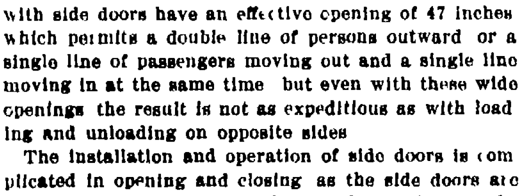
An Instructive Barogram

We are indebted to the Taylor Instrument Companies for permission to reproduce the accompanying barogram which was obtained by Mr P R Jameson F R Met S in the course of a voyage around the world The particular week s record here shown was made on shipboard between Mozambique and the coast of British East Africa i e the vessel was going nearly due north and passed through about 12 degrees of latitude during the week

While this record offers nothing of special note from a meteorologist s point of view it is in fact a perfectly normal record for the region and season in question, making allowance for the fact that the barograph had probably not been adjusted for some time and read much too low It is presented to our non meteorological readers as a pretty illustration of the very regular diurnal fluctuations of the barometer within the tropics, with the additional effect due to a rapid translocation of the instrument in latitude The ship was sailing from a region in which the barometric pressure is permanently high—viz the ridge of high pressure in the neighborhood of the Tropic of Capricorn—toward one in which it is permanently low viz the doldrums —the belt of calms near the equator between the two trade-wind belts This accounts for the progressive fall of pressure from the beginning to the end of the record The effect is however somewhat greater than would be expected from the normal distribution of pressure in this region and was possibly heightened by an accidental tilting of the trace sheet with respect to the revolving cylinder of the barograph.

If the reader will compare this barogram with one made in temperate latitudes he will be struck by the clock like regularity with which a maximum of pressure occurs at 10 A. M and a minimum at 4 P M, with secondary maxima and minima at 10 P M and 4 A. M., respectively There is an oft-quoted saying of Humboldt's to the effect that so regular is the daily rise and fall of the barometer within the tropics that the time of day may be inferred from it with considerable accuracy. The daily range averages about one-tenth of an inch of the mercurial column Day after day the history of the barometer repeats itself The monotony of the process is varied only—and at any given place this occurrence is fortunately rare—when a tropical hurricane passes near the point of observation Hence in tropical countries any departure of the instrument from its accustomed daily course is looked upon as ominous

In temperate regions the barometer has a similar double diurnal period but the periodic range is less and near the poles it is almost *nil* Moreover outside the tropics this daily oscillation is as a rule completely



AN INSTRUCTIVE BAROGRAM

masked by the passage of those widespread areas of hyperpressure and hypopressure that we call respectively, highs and lows Within the tropics these disturbances are almost unknown except for the small but intense lows known as tropical cyclones or hurricanes. Furthermore the latter are in any given region, limited to a particular season of the year and they rarely if ever, occur over the southern Indian Ocean during September the month in which the accompanying record was made

The cause of the double daily oscillation of the barometer is one of the time-honored riddles of meteorology No one has yet completely unraveled it, though of late much light has been thrown upon the subject The daily march of temperature—with a minimum in the morning and a maximum in the afternoon—would lead us to expect a *single* daily oscillation of atmospheric pressure When the air near the earth s surface is heated it expands pushes its way upward and overflows, thus diminishing the total mass of the air over the heated region and causing the barometer to fall The converse occurs when the air is cooled, and then the barometer rises This process alone would give us a daily maximum and a daily minimum of pressure twelve hours apart, instead of two maxima and two minima, at intervals of six hours such as actually occur

The explanations of this double period hitherto offered are too intricate to explain here in detail An analysis of pressure records obtained in all parts of the world has shown that the curve representing the daily march of the barometer at any place is really a composite of two curves One of these has a daily period and is evidently a local temperature effect the other which is the more regular of the two appears to depend upon the normal vibration period of the whole atmosphere a resonance effect as it is technically called The reader who desires to pursue this subject further may do so in Hann s Lehrbuch der Meteorologie (2d ed Leipzig 1906)

Fruit Disease Investigations

The investigation and study of fruit diseases have been vigorously pushed and have shown a healthy progress The destructive tumor disease of limes and other citrus fruits has been shown to be of fungus origin and attacks oranges as well as limes The new methods of spraying with sulphur compound worked out by the pathologists of the Department has been widely adopted by apple growers The investigation shows that fine fruit can be produced and protection secured against fungus disease without the injurious effect resulting from copper compound Bordeaux mixture is still being used but in the spraying of apples it has taken second place Special attention has been given to experimental work in perfecting the method of using the new sulphur sprays for the fruit spot and leaf disease As a result fruit growers who have used the new sprays have secured fine crops of the best apples they have ever grown Spraying has very largely prevented the fruit spot and leaf disease known as cedar rust or orange rust prevalent in the Blue Ridge and Allegheny mountain district from Pennsylvania to Tennessee The peach growers of Virginia West Virginia, and Georgia have been prompt to adopt the discovery of spraying with self boiled lime sulphur for brown rot and scab which has resulted in the removal of some of the factors which rendered the growing of this fruit uncertain The pear blight eradication methods have been in extensive use on the Pacific coast

Much space is given in discussing the work of the Bureau of Entomology to the important work that bureau has done during the past year in its effort to control or eradicate the gipsy moth and the brown tail moth The infested territory covers all the New England states excepting Vermont, and the Department working in co-operation with the authorities of those states has met with gratifying success Conditions there are largely improved

Mechanical Aids to the Study of Marksmanship

A German Army Officer's Invention

Lieutenant von Stegar of the German army has invented a simple apparatus which facilitates instruction in marksmanship and shows the recruit the character and extent of the error made in aiming. This apparatus which is described and illustrated in *Kriegstechnische Zeitschrift* is made in two parts. The first part (Fig 1) is a pair of sights of the point and notch type used on rifles constructed on an enlarged scale and so mounted on a tripod that it can be turned in any direction. The height of the point and the breadth of the notch are each about two inches and the point and notch are mounted on the ends of a strip of wood about three feet long which is attached to the tripod by a double joint moving with slight friction. The second part (Fig 2) is an adjustable sight hole consisting of a wooden disk with a perforation one-fifth of an inch in diameter which is attached to a tripod by a jointed arm moving with slight friction.

It has been the practice of instructors in marksmanship to employ enlarged wooden sights laid one upon the other for the purpose of showing the correct and incorrect positions of the point with respect to the notch but many unintelligent recruits cannot understand the demonstration because the sights on the rifle are not in contact, but are widely separated. Much better results can be obtained with the new apparatus. The recruit stands a pace or two behind the sight hole and looks through it at the pair of sights one pace farther forward. No target is required. By means of the adjustable sight hole the eye can be fixed in any position and the correct relative positions of the point and notch as well as any deviation therefrom can be easily demonstrated.

In the exercise in which the pupil is required to designate the point at which a rifle has been aimed by the instructor the pair of sights is placed ten paces from a disk of cardboard or canvas, with the point nearest the target. The instructor aims the sights and the recruit, standing about one pace from the notch indicates the point on the target at which he thinks the sights are aimed. This point of the target is marked with a black patch. The instructor then places the sight hole before the pair of sights so that an eye looking through the hole sees the notch bisected by the point. If the recruit has judged correctly the black patch will be seen directly above the point, but if he has judged incorrectly the patch will be seen to the right or left of the point (Fig. 4). The recruit, looking through the sight hole, can thus see his error. Or the sight hole may be so placed that the patch appears exactly over the point. In this case the error is shown by the unsymmetrical position of the point in the notch (Fig 5).

The apparatus is used in a similar way in the exercise in which the pupil is required to aim at a mark chosen by the instructor and the error is shown, as before by using the sight hole which is adjusted by the instructor. The apparatus is not intended for universal use but only as an aid in the instruction of the less intelligent and especially awkward recruits, where it saves much time and vexation and teaches accuracy of aim. The pupil sees his own error because his eye is brought to the correct position by the sight hole. Without the apparatus the instructor can only say that the gun is aimed too high, too far to the right, etc but the recruit has to take this verdict on faith and is little helped by it. The movable pair of sights might be dispensed with and the sight hole attached to the butt of the rifle but this arrangement would be less convenient and less accurate owing to the nearness of the hole to the notch.

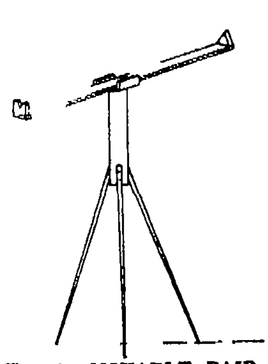


Fig 1—MOVABLE PAIR OF SIGHTS

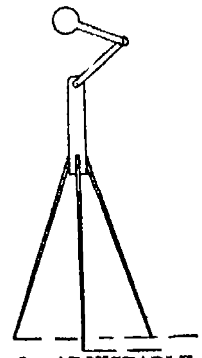


Fig 2—ADJUSTABLE SIGHT HOLE

Fig 4

Fig 5

Fig 3—THE APPARATUS IN USE

A Handsome County Bridge

A Reinforced Concrete Bridge Connecting Asheville with West Asheville

The handsome reinforced concrete bridge represented in the illustration spans the French Broad River connecting the city of Asheville with West Asheville a thriving and energetic little city of 3 500 people. The entire construction is of reinforced concrete with a total length of 931 feet 6 inches. It is composed of two clear spans of 145 feet each with an east approach of 475 feet and a west approach of 135 feet. The distance from the top of the bridge at the center of the arc to the water at normal level is 50 feet. The structure has a 30 foot roadway with an electric car line in the center and a 12 foot 6 inch clear roadway on each side of the rail. It was designed for a capacity of three 35 ton electric cars. The total cost of the bridge was $70 000 and including right of way and incidentals $72 000. R P Johnston of Asheville N C was the engineer and C B Clarke & Company Baltimore were the contractors. The bridge was opened to the public on February 10th 1911.

The Asheville Electric Company is extending its line across the bridge to the western portion of West Asheville a distance of a little more than two miles at a cost of nearly $40 000. Large forces are at work at both ends of the line and cars are expected to be in operation by April 1st 1911.

Soil Surveys

During the year soil surveys were carried on in fifty nine different areas in twenty-six different states and as a result 32 762 square miles were covered in detailed work and 79 108 square miles of reconnoissance surveys, mainly in the Great Plains region. A total area of 359 564 square miles or 230 120 960 acres has been surveyed and mapped since active field work was begun in 1899.

It is now clear that the pioneer methods of agriculture are inadequate for the increasing needs of our growing population. There is also abundant evidence that with a thorough knowledge of the soils and the intelligent application of modern intensive methods the yields per acre of our staple crops can be increased many times.

The soil surveys are showing the vast opportunities for crop specialization in the various soils in different sections of the country. Reconnoissance surveys of the Great Plains region thus far made have furnished a large amount of valuable and accurate information not only to prospective settlers but also to those farmers who are already in the areas.

A REINFORCED CONCRETE BRIDGE SPANNING THE FRENCH BROAD RIVER AT ASHEVILLE, N. C.

Curved Photographic Plates*

Their Advantages in Astronomical Photography

By F A Bellamy, Hon M A (Oxon), F R A S

A SHORT note on the subject of curved photographic plates may be of interest. From the earliest days in photographic astronomy one of the difficulties to be met and overcome was the curvature of the field or the rapid falling off in the definition or good focus in the images of the stars away from the center of the photographic plate It is obviously of the greatest importance for accuracy and utility for uniformly good quality definition to be obtained over as large an area on the plates as possible

To an astronomer the reduction of the aperture of the photographic lens is not permissible or at least usually very inadvisable for stellar work as the maximum aperture is required in order to reduce the time of exposure as much as possible.

Though curved plates have in the past been suggested and used with a view to overcome the want of good focus beyond a very limited area, they have never found favor with astronomers for various reasons among these being the difficulty of making them uniformly suit the area of good focus simultaneously at the center and the edges the great cost of making satisfactory plates (uniformly coating them) greater risk of breakage difficulty of measurement storage and so on When the first conference in connection with the Astrographic Survey was held in Paris in 1887 one of the subjects proposed and discussed was the use of curved plates for the survey The plan was rejected as not feasible In twenty three years knowledge has advanced and the utilization of methods and appliances—common in other branches of science—has greatly increased so that what was impossible or inconvenient years ago is now rendered more convenient and available for use

The suggestion to use curved plates has been brought up again This time from a personal acquaintance with the worker and his excellent work we may say that there is a much greater chance of the method being tried under every condition that promises success which we hope will ultimately be achieved by Dr J H Metcalf

The lens he is using is a Petzval doublet and the focal length is seven times the aperture and gives a scale of picture of 90 inches to 1 millimeter With this lens he has found by re-focusing for various parts of the plate that all parts of a 10 inch by 8 inch plate equal to an area of 5 degrees square can be brought into good focus and excellent star images obtained As the lens can do so much by merely altering the focus gradually between the center and the edges the extreme amount to be allowed for in changing the focus for these two positions is only three one-hundredths of an inch (0 8 millimeter) it seems quite possible to bend a plate temporarily by that amount without fracture

* *Knowledge*

FIG 1—THE CENTER OF THE PLATE

Two exposures were made on the same plate the left hand one with the plate curved the other with it flat

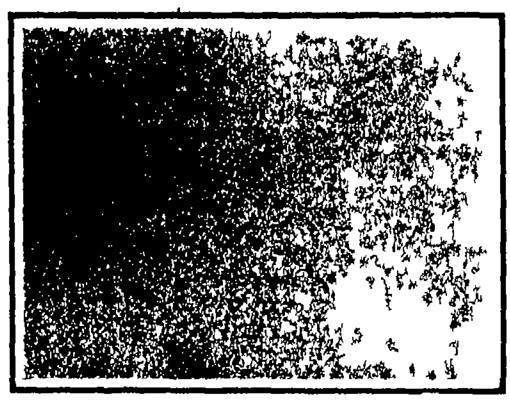


FIG 2—THE EDGE OF THE PLATE

Here there were two exposures as in Fig 1

Various methods were tried to produce the required amount of bending artificially of these the most successful as one might expect is that produced by atmospheric pressure on the outer and film side surface of the plate caused by exhaustion of the air in a closed chamber at the back of the plate

From a trial made with the 16 inch Metcalf telescope in 1910 June 29th ocular evidence can be obtained by the examination of the two sets of star images shown on the accompanying illustrations The region is that surrounding R A 19h 0m and +5 degrees and is enlarged nine times from the original plate so that 10 inches equal 1 millimeter In obtaining these two exposures the first and left hand image was taken with the plate temporarily curved and the second image shows the same star with the plate flat each exposure was of ten minutes duration In Fig 1 the center of the plate is substantially in the same focus the flat plate image being slightly the better one of the two When the outer parts of the same plate are compared a marked improvement becomes obvious with the curved plate images the bright stars showing less diffusion and naturally smaller images there being less scattering of light and the faint stars—the stars light being more compact and in focus—are distinctly improved almost invisible and diffused images become quite visible and better formed

Further plates have since been taken with that instrument to test the effect on the determination of magnitude and of position From an examination of sixty-one stars fainter than the 10 1 magnitude it was found that the flat plate lost 0 17 magnitude at 1 5 degree from the center in the curved plate the brightness increased by 0 06 magnitude No systematic error was detected

The effect on the actual positions of the stars has not yet been determined this requires careful and accurate measurement of a number of plates preferably of the same area.

For the convenience of use storage and measurement it will be a distinct gain to be able to have the plates flat rather than have to deal with plates with a permanent curvature When the temporarily curved plates are measured there are obvious advantages in having them flat in the measuring instrument.

The plate reproduced here is from the Harvard Circular No 161

Knowing Dr Metcalf's skill in practical photographic astronomy and his power to overcome difficulties we may expect still better results from his instruments

A Concrete Potato Peeler

A NOVELTY in cement construction is a concrete potato peeler It is an urn shaped reinforced concrete vessel which has a revolving disk in the bottom of the bowl driven from below through bevel gearing and designed to spin the potatoes around the inside of the bowl The rough surfaces on the disk and bowl rub off the potato skins and several sprays of water injected at the upper edge wash the potatoes clean and carry the refuse out at the bottom It peels a peck of potatoes perfectly in two minutes and while the machine is still running a door in the side is opened and the potatoes are ejected by centrifugal force into a galvanized iron receptable A motor of one-half horse-power capacity furnishes ample power and the driving pulley is proportioned to give six hundred revolutions per minute to the disk It is claimed that the machine saves twenty per cent of potato which is wasted by hand peeling to say nothing of the saving in labor and time Deep eyes and corners in irregular potatoes must of course be removed with a knife

The machine is cast upside down using mortar of a consistency which pours readily The mold is made of cast iron in several sections, and includes a collapsible core for making the bevel gear chamber below the peeling bowl After the concrete has stood in the mold for several hours and has hardened sufficiently the mold is inverted and the inner surface of the bowl is roughened with a steel brush —*Concrete Age*

CONCRETE POTATO PEELER

Work Among Southern Farmers

AS A result of the teaching of the methods of the Department for scientific farming, farmers throughout the country have increased their yields. The demonstration work among southern farmers has shown excellent results and progressive growth. Organized in 1904 for the purpose of fighting the boll weevil in Texas, this work has now extended to all the southern states. The boll weevil has been fought progressively and where the farmers have followed the instructions of the agents of the Department an average crop of cotton has been produced in spite of the weevil and statistics show that on the other hand where planters have not followed the instructions a crop failure has resulted This is conspicuously true in the alluvial sections of Texas, Louisiana, and Mississippi The methods advocated are being adopted by farmers in the boll weevil infested territory and are fast being recognized as the best means yet presented of raising a crop of cotton in spite of the boll weevil This means the restoration of confidence and credit and prevents the abandonment of farms and emigration of labor to other fields From 1904 to the present time the agents in this line of work have been increased from 1 to 450 and the demand is growing. More than 75 000 farmers are receiving direct instruction on their farms

Potash Salts: Light on an International Controversy—I*

Uses and Occurrence of Potash in the United States

By W C Phalen

INTRODUCTION

The many inquiries that have come to the Geological Survey for official information regarding American sources of potash have rendered advisable the publication of the available data on this subject Chapters on potash salts were published in the annual reports on mineral resources of the United States for 1887 and 1904 The more important statements in these summaries are here republished and expanded in the light of later observations and other information procured by the Survey geologists chemists and statisticians

Potash salts are used extensively in the United States They are essential to numerous industries that are vitally connected with the welfare of the American people—the most notable being the fertilizer industry They are used also in the manufacture of glass in certain kinds of soap in some explosive powders and in the chemical industries including the manufacture of alum cyanides bleaching powders dyestuffs and other chemicals among which are arsenite of potassium bromide of potassium chlorate of potassium permanganate and manganate of potassium nitrate of potassium and silicate of potassium

DOMESTIC POTASH INDUSTRY

Practically all the potash salts of mineral origin consumed in the American industries at present are imported from abroad chiefly from Germany There was a time in the history of the potash industry however when the United States produced a large part if not all of the potash it consumed The burning of wood and the lixiviation of the resulting ash to extract the potash though of minor importance so far as the monetary value of the product is concerned is one of the oldest of the purely chemical industries in this country Cognizance was taken of it in the census reports as early as 1850 so that data are available for comparing the condition of the industry for each decade since that year In the following table are given the quantity and value of potash produced in the United States from 1850 to 1905

Potash salts produced in the United States 1850 to 1905[1]

Census	Number of Establishments	Product		Average Price per Pound
		Quantity	Value	
		Pounds		
1850	549		$1 401 588	
1860	219		538 550	
1870	105		337 071	
1880	68	4 5 1 671	282 648	$0 061
1890	76	5 106,939	197 507	0 039
1900	[a]0	8 804 706	178,180	0 049
1905	[a]49	1 811 087	104 655	0 058

[1] Munroe C E Bull 9 Census of Manufactures Bur Census 1905 p 18

[a] Includes establishments engaged primarily in the manufacture of other products

According to C E Munroe the figures given above show a constant decrease in the total value of the potash produced in this country since 1850 and a steady decrease in the quantity of the product since 1890

This seems quite reasonable in consideration of the destruction of the forests during recent years and the resulting decrease in the quantity of ashes readily available for the manufacture of potash also in consideration of the decrease in the native fertility of the soil with which has come an inclination to return potash to the soil as it occurs in the ashes rather than to extract and market it and also in consideration of the cheapening of soda or hard soaps and increased facilities for bringing them to agricultural communities whereby the temptation to extract potash from ashes for the manufacture of potash or soft soaps is lessened These causes combined with the comparative cheapness of foreign potash, tend to destroy the domestic industry The data given in the above table indicate that the industry is a waning one and that it may come to be of so slight importance as not to warrant separate consideration in subsequent censuses, unless other causes recently set in operation shall revive it in another form."

IMPORTATION OF POTASH SALTS

The potash industry has not been revived in the United States thus far and the great bulk of the potash salts now used are imported. The following table shows the magnitude of the importation of potash salts for the years 1900 1905 and 1910

Imports of potash salts for the calendar years 1900 1905, and 1910, in pounds.[1]

(Figures from Bureau of Statistics.)

	1900		1905		1910	
	Quantity	Value	Quantity	Value	Quantity	Value
	Pounds		Pounds		Pounds.	
Chlorate	1,348,619	$88,779				
Chloride	130 175,481	1 976,604	214 207 064	$3,396,478	391,873,875	$5,252,378
Nitrate (Crude and refined)	10 515,399	276,654	9 911,584	304,596	11 406,904	338,854
All other including carbonate (crude and refined) bicarbonate, caustic (crude and refined) chromate and bichromate cyanide hydriodate, iodide, iodate permanganate prussiate (red and yellow) sulphate (crude and refined)	54,904 098	1 407 808	82,935,532	1 891 081	116,890,878	2,777,396
Total	196 868,578	$3,729 343	307 054,180	$5,592,155	510,191 659	$8,368,623
Increase			110 185,573	1 792,819	203,137,523	2,841 468
Percentage of increase			55 96	48 07	66 15	51 45
Kainite kyanite and kieserite, and manure salts[2]	590,605 190	$1 508,217	830 908,360	$3,116,884	1 283,199 360	$3,951 511

[1] This table is based on total imports for the calendar year not, as nearly all the import tables in this volume on imports for consumption for the calendar year

[2] These figures are for the fiscal years

THE CHEMICAL MANUFACTURES IN THE UNITED STATES DEPENDENT ON IMPORTED POTASH SALTS

Potash

Under the head of potash are included potassium carbonate and caustic potash Potassium carbonate is made from potassium chloride by the LeBlanc process in the same way as soda ash from salt, but the ammonia process can not be employed because the acid carbonate of potassium ($KHCO_3$) is soluble in ammoniacal solutions and does not precipitate The material is sold in the trade under the name potash or pearlash and is used chiefly in the glass industry in the manufacture of caustic potash and in the manufacture of chromates of potassium A considerable quantity is bought by soap makers and causticized the solution being used for soft soaps

Caustic potash (KOH) is made in the same way as caustic soda It is much more deliquescent than the corresponding sodium compound and is generally made where it is to be used In soap making it was formerly customary to saponify the fat with caustic potash and then to add common salt. An interchange between the potassium and sodium took place the result being a hard sodium soap But as soda is now cheaper than potash and yields a hard soap directly potash soaps are used only for special purposes

The consumption of potash or pearlash in the glass industry of the United States at the census of 1890 was 2 644 978 pounds valued at $135 047 and at the census of 1900 4 406 211 pounds valued at $186 047 The percentages of increase in quantity and value are respectively 73 and 38 The quantity of potash used in the soap industry at the census of 1905 was 4 453 800 pounds valued at $191 933 but this does not include the potash produced and consumed in the same establishments in the manufacture of soft soap Glass and soap making are two of the industries in which the largest quantities of potash as such are used

The following table shows the imports of potash and ashes for three years—1904 1905 and 1910

Imports of potash and ashes 1904 1905 and 1910

Year Ending June 30	Imports of Bicarbonate of Potash		Imports of Carbonate of Potash			
			Crude or Black Salts		Refined	
	Quantity	Value	Quantity	Value	Quantity	Value
	Pounds		Pounds		Pounds	
1904	96,769	$4,778	8,193,873	$294 896	18,596,306	$397 104
1905	76,965	4,504	7 166,569	218,816	18,667 068	440,189
1910	334 500	16,688	8,407,873	263 643	9,036 267	308,917

Year Ending June 30	Imports of Caustic or Hydrate of Potash				Imports of Ashes (Wood) and Lye of and Beet-root Ashes (Value)
	Not Including Refined in Sticks or Rolls		Refined, in Sticks or Rolls		
	Quantity	Value	Quantity	Value	
	Pounds		Pounds.		
1904	4,810,996	$194,889	36,048	$4 879	$62,641
1905	5,269 604	217 041	32,818	2,537	60,718
1910	8,785,491	308,606	141 480	11 096	60,380

Alums.

In the manufacture of potash alum ($K_2SO_4.Al_2(SO_4)_3.24H_2O$) large quantities of potassium sulphate are used. On the addition of the potassium sulphate to the sulphate of alumina, the potash alum crystallises out in extremely pure form Alum is extensively used in the dyeing industry as a mordant and by paper makers and leather dressers. A small quantity is used in medicine. The following table gives the quantity and value of potash alum manufactured in the United States at the censuses of 1900 and 1905 The figures for 1910 are not yet available

Potash alum manufactured in the United States, 1900 and 1905

	Quantity	Value.
	Pounds.	
1900	14 200,393	$315,004
1905	10,807 154	156 448

Cyanides and Derived Compounds

The class of cyanides comprises potassium cyanide or white prussiate of potash sodium cyanide and other simple cyanides including cyan-salt," a mixture of potassium and sodium cyanides, potassium ferrocyanide (yellow prussiate of potash) potassium ferricyanide (red prussiate of potash), there are also the cyanates and ammonium and potassium sulphocyanates etc

Potassium cyanide (KCN) is generally made by fusing potassium ferrocyanide with potassium carbonate until the evolution of gas ceases The following is the reaction

$K_4Fe(CN)_6 + K_2CO_3 = 5KCN + KCNO + CO_2 + Fe$

The metallic iron that is produced sinks to the bottom of the crucible and the fused mixture of cyanide and cyanate is run off The addition of powdered charcoal reduces part of the cyanate to cyanide The product thus prepared is pure enough for many purposes The commercial salt always contains cyanate and carbonate and is sold in various grades depending on the purpose for which it is to be used The best quality contains about 98 to 99 per cent KCN but ordinary grades contain only 65 to 70 per cent It is a very powerful reducing material when heated with reducible substances and hence its use as a flux It is extremely poisonous, either when taken internally or when introduced directly into the blood. It is extensively employed in electroplating as the solvent in the bath forming soluble double cyanides with gold, silver copper, and other metals It is also used as a flux in assaying and metallurgy Its greatest use at the present time is for the recovery of gold from low-grade ores and the tailings of other reduction processes. A weak solution is used to dissolve the gold, forming aurous potassium cyanide (AuCN KCN) It was formerly used in photography for 'fixing the image but for this purpose it has been largely replaced by sodium thiosulphate

Potassium ferrocyanide ($K_4Fe(CN)_6.3H_2O$) also called yellow prussiate of potash, is made by fusing together potassium carbonate, iron borings, and nitrogenous organic matter of any kind, such as horn hair, blood wool waste, and leather scraps The material in its pure form is produced in splendid large lemon yellow crystals. It is not poisonous. It is largely used for making Prussian blue, in calico printing and in dyeing, for case hardening iron, for making potassium cyanide and ferricyanide, and to a small extent in explosives, and as a chemical reagent.

Potassium ferricyanide or red prussiate of potash (K_3FeCN_6) is usually made by passing chlorine gas into a solution of the ferrocyanide until ferric chloride no longer forms a precipitate, but produces only a brown color in the liquid. It may also be made by exposing the dry powdered ferrocyanide to chlorine until a test portion dissolved in water gives nothing but a brown color, with ferric chloride. With ferrous

* Reprint of a bulletin issued by the U S Geological Survey

[1] Op cit pp 38 et seq

salts it gives the blue pigment, Turnbull's blue Its solution with caustic potash is a powerful oxidizing liquid, and as such is used in calico printing for a "discharge" on indigo and other dyes. It also forms part of the sensitive coating of blueprint papers. It has been recommended for use with potassium cyanide solution in gold extraction.

The following table shows the magnitude of the cyanide industry in the United States at the censuses of 1900 and 1905 The figures for the census of 1910 are not yet available

Potassium cyanide manufactured in the United States, 1900 and 1905

	1900	1905	Increase	Per Cent of Increase
Quantity pounds	8,460,989	11 196,318	2,735,329	32 3
Value	$1,595 505	$1 710,823	115,318	7 2
Value per pound	$0 189	$0 153		

Fertilizers

The class of fertilizers comprises numerous chemical compounds among them the so-called complete fertilizers which consist of superphosphate of lime potash salts, and ammoniacal compounds or nitrates The following table gives the quantity and value of complete fertilizers manufactured in the United States at the censuses of 1900 and 1905 together with the amount and percentage of increase The figures for the census of 1910 are not yet available

Complete fertilizers manufactured in the United States, 1900 and 1905

	1900	1905	Increase	Per Cent of Increase
Quantity tons[1]	1 478,898	1 608,847	125,081	8 5
Value	$56,818 995	$61 805 057	$4 986,062	18 9

[1] The ton used in this report is the short ton = 2 000 pounds except where otherwise stated

The following table gives the quantity and value of the principal potash materials used in fertilizers in the United States at the two censuses cited with the amount and percentage of increase the figures for the census of 1910 not being available This table includes only the materials used in the principal establishments in the United States

Principal potash materials used in fertilizers in the United States 1900 and 1905

	1900	1905	Increase	Per Cent of Increase
Kainite				
Quantity tons	54 700	190 492	135 08	248 3
Value	$540,558	$1 891 073	$1 370 240	263 1
Potash Salts				
Quantity tons		122 107		
Value	$3,098,400	$3,606 701	$508 801	16 4
Nitrate of Potash				
Quantity tons	864	1 160	296	31 2
Value	$82,156	$99 039	$6,883	21 4
Wood Ashes				
Quantity bushels		1 063		
Value		$2 050		

Bleaching Materials

The class of bleaching materials includes among a great many other chemicals potassium bisulphite The following table gives the quantity and value of bisulphites manufactured in the United States at the censuses of 1900 and 1905 with the amount and percentage of increase the figures for the census of 1910 not being available Potassium bisulphite forms a very small part of the total

Sodium potassium, calcium and other bisulphites manufactured in the United States 1900 and 1905

	1900	1905	Increase.	Per Cent of Increase.
Quantity tons	1 461	6 268	4,788	325 9
Value	$34,486	$110,155	$75,669	219 4

Chemicals Produced by the Aid of Electricity

Among the chemicals produced by the aid of electricity are potassium chlorate and potassium hydroxide. The following table gives the quantity and value of the potassium salts made electrolytically at the censuses of 1900 and 1905, with the amount and percentage of increase, the figures for 1910 not being available

Potash salts made electrolytically in the United States, 1900 and 1905.

	1900	1905	Increase.	Per Cent of Increase.
Quantity, tons.	1,900	3,908	2,008	105 7
Value	$90,097	$209,008	$119,911	140 7

Dyestuffs

Potash salts enter into the dyeing industry chiefly in the form of alum. The production of alum has already been given and will not be repeated here. Potassium sulphide is frequently used to improve the fire' in vermilion. Potassium bichromate is extensively used in the manufacture of chrome green.

Explosives

Potash salts in the form of nitrate enter into the manufacture of gunpowder The term gunpowder generally includes the nitrate-sulphur-charcoal combination used in blasting as well as that used in guns and for the last fifty years it has included the blasting powder made with nitrate of soda as well as that made with nitrate of potash Potassium nitrate is also a constituent of some of the higher grade explosives tested and listed by the Bureau of Mines as permissible explosives Potassium nitrate is made by the double decomposition of sodium nitrate with potassium chloride the former being largely imported from Chile The reaction ($NaNO_3 + KCl = NaCl + KNO_3$) is very simple The following table gives the quantity and cost of nitrate of potash used in the explosives industry in the United States in the years 1900 and 1905 the figures for 1910 not being available

Potassium nitrate used in the manufacture of explosives in the United States 1900 and 1905

	1900	1905
Quantity tons	8,315	4 114
Value	$270 186	$306,644

General Chemicals

Under the heading of general chemicals potash enters into the composition of a host of substances Some of these are arsenite of potassium used in the dyeing industry bromide of potassium used in photography and medicine chlorate of potassium used in fireworks matches and aniline colors chromate of potassium used in dyeing and electricity manganate and permanganate of potassium used in dyeing and bleaching in disinfectants and in medicine silicate of potassium used in making ordinary yellow soaps as a fixative for pigments in calico printing as a vehicle for pigments in fresco painting for rendering cloth and paper non inflammable etc cream of tartar and argols

THE DEPOSIT OF POTASH SALTS NEAR STASSFURT GERMANY[1]

Discovery

Although potash occurs in many forms and places in the United States as described in a subsequent part of this report up to the middle of the nineteenth century wood ashes constituted practically the sole source of supply In 1857 a shaft which the German government had been sinking for about five years near Stassfurt reached a depth of approximately 1 100 feet but in the meanwhile had passed through a deposit of so-called Abraumsalze or refuse salts consisting largely of compounds of potash and magnesia then considered worthless[2] This deposit is now and long has been the chief source of potash and the potassium salts of commerce It is estimated by C Ochsenius[3] that the German deposit of potash salts may last over 600 000 years

Theory of Occurrence

The theory developed by Ochsenius for the occurrence of salts at Stassfurt is briefly as follows A deep bay is imagined connected with the sea by a narrow and shallow channel but otherwise cut off from oceanic circulation by a bar If no large streams enter the bay the outflow from it will be small but sea water can enter freely to offset the losses due to evaporation Evaporation of course takes place only at the surface, and the upper layers thus becoming denser must sink, producing a saline concentration at the bottom In this manner being continually supplied with new material from without the salinity of the bay will gradually increase until saturation is reached and the deposition of salts begins So long as salt water can enter the bay this process will continue and the depths of the basin will in time become a solid mass of salt, covered with a sheet of bittern If meanwhile an elevation of the land takes place separating the bay completely from the ocean evaporation may proceed to its limit and the mother liquor containing the more soluble salts including the potash salts will deposit its contents in more or less well-defined layers above the salt at the bottom. In the Karaboghaz and other bays on the eastern shore of the Caspian Sea the process of saline concentration can now be observed in actual operation, but only part of the programme has yet been performed.

This theory of Ochsenius is not the only one possible to account for the concentration of salts It must be remembered that salt is not deposited from sea water until it has been concentrated to about one-tenth of its original volume. Suppose now a large sheet of water in whose bottom there is a deep depression be cut off from the ocean by any change in the level of the land The water in the depression will gradually become concentrated and its saline load will tend to accumulate there A layer of salt will thus form of much greater thickness than if evaporation took place over a comparatively level bottom and if the surface area of the depression is small in comparison with that of the original sheet of water the depth of the deposit may be very great Such a deposit might also be reinforced by leaching from other salt beds or from diffused salts in adjacent areas—a process which is now going on in the valley of the Dead Sea and in certain lakes of the arid region of the western part of the United States

Salts Deposited

In the Stassfurt or more properly the Magdeburg Halberstadt region the order of deposits from the surface downward is as follows

1 Drift about 8 meters (26 feet) thick

2 Shales sandstones and unconsolidated clays of varying thickness

3 Younger rock salt thickness very variable sometimes missing

4 Anhydrite rarely lacking 30 to 80 meters (98 to 262 feet) thick.

5 Salt clay average thickness 5 to 10 meters (16 to 33 feet) very rarely absent

6 The carnallite zone from 15 to 40 meters (49 to 131 feet) thick At Douglashall a layer of rock salt intervenes between the carnallite and the clay In parts of the field kainite overlies the carnallite is itself overlain by sylvinite or hartsalz and that in turn by schoenite These subzones are often missing

7 The kieserite zone

8 The polyhalite zone

9 Older rock salt and anhydrite Nos 7 8 and 9 have a total thickness ranging from 150 to perhaps 1 000 meters (492 to 3 280 feet) The anhydrite forms layers averaging 7 millimeters (0 27 inch) thick separating the salt into sheets of 8 or 9 millimeters (0 31 or 0 35 inch) These layers have been interpreted as annual deposits due possibly to seasonal variations in temperature or to alternating drought and rain If this supposition is correct a Stassfurt salt bed 900 meters (2 953 feet) thick would require 10 000 years to form

10 Anhydrite and gypsum

The above is a complete record of the saline deposition at Stassfurt ranging from the calcium sulphate at the bottom to the mother liquor or carnallite salts at the top Above the carnallite a protecting layer of clay was laid down and after that probably a new accession of sea water began the formation of a second series of beds which however are regarded by some as having resulted from the re-solution and redeposition of older beds

In the Stassfurt deposits more than 30 saline minerals have been found some of which are regarded as primary and others as derived from the primary minerals by secondary reactions A few are simple salts but the bulk are double compounds Chlorides sulphates and borates are most common but the mineral kainite contains both the chloride and sulphate radicles The sulphates found at Stassfurt are as *follows*

Anhydrite	$CaSO_4$
Gypsum	$CaSO_4\,2H_2O$
Glauberite	$CaSO_4\,Na_2SO_4$
Polyhalite	$2CaSO_4\,MgSO_4\,2H_2O$
Krugite	$4CaSO_4\,MgSO_4\,K_2SO_4\,K_2SO_4\,2H_2O$
Kieserite	$MgSO_4\,H_2O$
Epsomite	$MgSO_4\,7H_2O$ (reichardtite)
Vanthoffite	$MgSO_4\,3Na_2SO_4$
Bloedite	$MgSO_4\,Na_2SO_4\,4H_2O$ (astrakanite)
Loewite	$MgSO_4\,Na_2SO_4\,2\frac{1}{2}H_2O$
Langbeinite	$2MgSO_4\,K_2SO_4$
Leonite	$MgSO_4\,K_2SO_4\,4H_2O$
Picromerite	$MgSO_4\,K_2SO_4\,6H_2O$ (schoenite)
Aphthitalite	$K_3Na(SO_4)_2$ (glaserite)
Kainite	$MgSO_4\,KCl\,3H_2O$

Little is heard of these salts except of kainite and this is of great importance It is readily soluble in water and most of its potash being immediately available as plant food it is used extensively as a fertilizer

The chlorides found in the Stassfurt region are as follows

Halite or rock salt	$NaCl$
Sylvite[1]	KCl
Douglasite	$K_2FeCl_4.2H_2O$
Carnallite	$KMgCl_3\,6H_2O$
Tachhydrite	$2MgCl_2\,CaCl_2\,12H_2O = 3(RCl_2\,4H_2O)$
Bischofite	$MgCl_2.6H_2O$
Rinneite	$FeCl_2.3KCl\,NaCl$

As already stated these chlorides represent the con

[1] Largely compiled or quoted from Clarke, F W Bull U S Geol. Survey No. 330, 1908, pp. 176 et seq.

[2] Potash in agriculture, The German Kali Works p 5

[3] Die Kunstdunger Industrie, vol. 11 No 9

[1] Sylvinite is a mixture of sylvite and rock salt Hartsalz contains these substances together with kieserite

centration of the mother liquors in the carnallite zone. They were the most soluble compounds existing potentially in the sea water and with the kainite $(MgSO_4 \cdot KCl \cdot 3H_2O)$ they were among the last substances to crystallize The chemistry of the deposition and the interreaction of these substances is most complex and the literature mostly in German is widely scattered

It must not be supposed that these zones of deposition are regularly and completely separated nor even that they represent in any close degree the products observed in the artificial evaporation of sea water or brine In the latter case a moderate quantity of water is concentrated by itself at Stassfurt more water was continually added from the ocean On the one hand calcium sulphate is deposited almost wholly at one time on the other, new quantities were precipitated so long as the evaporating bay retained its connection with the sea. In the salt pan gypsum $(CaSO_4 \cdot 2H_2O)$ forms a bottom layer before salt begins to separate out; at Stassfurt anhydrite $(CaSO_4)$ is found in greater or less amount through all the zones, and so also is salt (NaCl) When a shallow lake or isolated lagoon evaporates, the artificial process is closely paralleled but a concentration, with continuous replenishment, lasting for thousands of years, is a very different thing. The principles are unchanged, the broad outlines remain the same, but the details of the process are greatly modified.

(To be continued.)

The Crane Collection of the New York Zoological Park*

How Cranes are Kept in a Great Paddock

By Lee S Crandall, Acting Curator of Birds

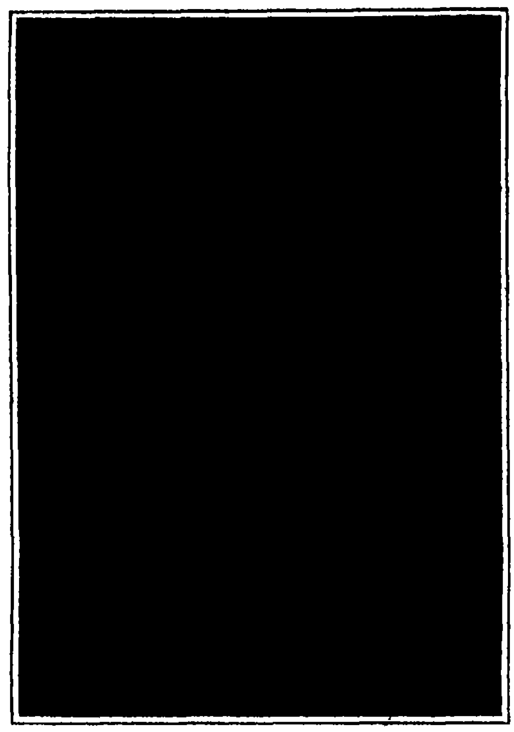
Among the many groups of birds possessing ornate qualities few are so hardy in captivity or thrive with such meager care as that formed by the cranes It is true that the ornamental value of these birds is not as yet fully recognized in America, although they are kept extensively on European estates still large numbers of cranes are brought to this country annually and there is no doubt that their popularity is steadily increasing

Captive cranes are perhaps of greatest interest when enjoying their liberty on an extensive range but the aviculturist who is truly interested in them will wish to confine his specimens where they can be kept under closer observation For this purpose a plot of two or three acres of ground should be selected and inclosed by a fence which need not exceed five feet in height The crane paddock in the New York Zoological Park is so nearly an ideal home for most of the members of the society's excellent collection that a description of it may be of interest

The paddock is about 150 feet square and is surrounded by an ornamental fence averaging four feet in height. While most of the inmates are pinioned they can leap this fence easily when alarmed although they never attempt to do so under ordinary circumstances The inclosure is well carpeted with grass which is kept closely cropped during the summer months A number of large shade trees is included within its limits besides several clumps of shrubs which afford seclusion to any birds which desire it One of the most valuable features however is a little stream that traverses the entire length of the paddock The birds derive an infinite amount of pleasure from wading and probing about in the little pools and the effect produced is certainly most pleasing to onlookers A small shed is provided for use during severe weather The Manchurian whooping white necked sarus and sandhill cranes are confined here while the others are divided between the wild fowl inclosure and the ostrich house

Few birds require so little attention as the cranes Their chief food is grain but occasional mice frogs fish or chopped meat are always appreciated and become a necessity during cold weather Many of the species are perfectly hardy provided healthy specimens are secured It acquired in the spring and given an opportunity for becoming acclimated they will live in the open through the winter happily and well requiring only that they receive their food and water regularly Some protection from wind should be provided of course and it is well to place within the inclosure a small shed although it is safe to say that the birds will use it rarely unless driven in

* Zoological Society Bulletin.



THE CROWNED CRANE (BALEARICA PAVONINA)

A surprising assiduity in the search for worms and tender roots is a failing which may become serious and result especially after rain in the uprooting of patches of turf Generally this can be checked effectively either by confining the birds for a short time following showers or by covering their favorite feeding grounds with small branches

The greatest difficulty in the maintenance of a large collection of cranes is found in the erratic disposition of the birds A number may live together for months in perfect harmony but just as the collector begins to congratulate himself on their good behavior one may be found with an eye missing or with its skull pierced' It really is not safe to associate the larger and smaller species in a permanent group unless the inclosure be very large or the number of birds very small Great care must be taken in introducing strange birds to a flock already well settled The new-comers are certain to be subjected to a more or less harrowing inspection by the original inmates who consider them as nothing more than intruders The strangers will be persistently driven from pillar to post for some days and will be fortunate indeed if they escape without some injury The safest way to establish a crane family is to place all of the intended members in the inclosure at the same time then none can use the prestige of previous occupancy as an excuse for tyranny Brought together in this abrupt manner the birds will soon learn to tolerate one another

The Order Gruiformes includes besides the true cranes six groups of remarkable birds such as the sun bitten the kagu and the seriema, which have been assigned to this order in lieu of a better place. Their structures are confusing and their relationships obscure The birds with which we are to deal here are divided into nineteen species which form the Suborder Grues and are cosmopolitan, with the exception that none are found in South America. Asia is particularly fortunate in being the home of seven species. Some of these birds are fairly easy to obtain alive but most of them are far from common in captivity and a few are seen rarely if ever

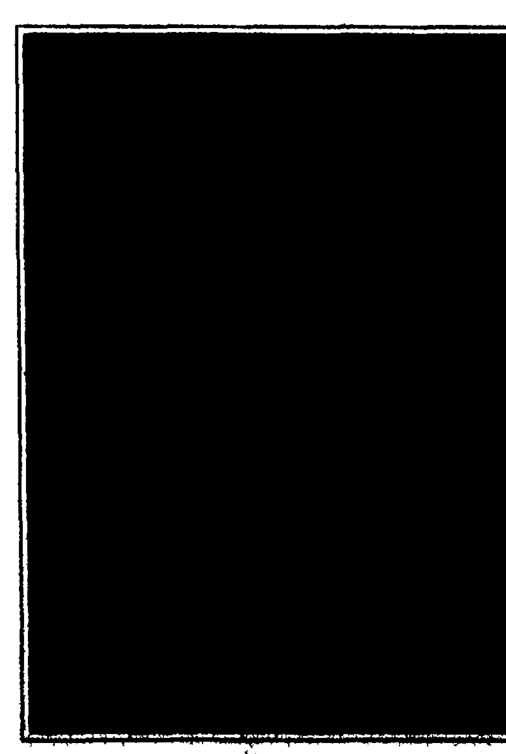
At present nine species all of which possess characters of interest are included in the Zoological Park collection Several of these are members of the genus *Grus* which includes the three species of North American cranes

The Sandhill crane (*G mexicana*) still is fairly common on the plains of western North America, where there is little cover to shelter skulking enemies, This is the most numerous of our cranes and therefore the best known It is rather small as compared with most of its relatives its length being about forty six inches its color is a uniform slaty gray with the bare skin of the crown reddish In captivity this crane becomes delightfully tame and is very hardy and long lived This species nested in the Zoological Park in 1904 and 1905 but the eggs proved infertile on both occasions

The little brown crane (*G canadensis*) is a very close relative of the sandhill and is distinguished by its smaller size and shorter tarsus It breeds through Arctic America and Siberia migrating to the western United States and Mexico for the winter The inaccessibility of its habitat explains its long confusion with the sandhill and also accounts for its scarcity in captivity The species is not represented in the collection at present.

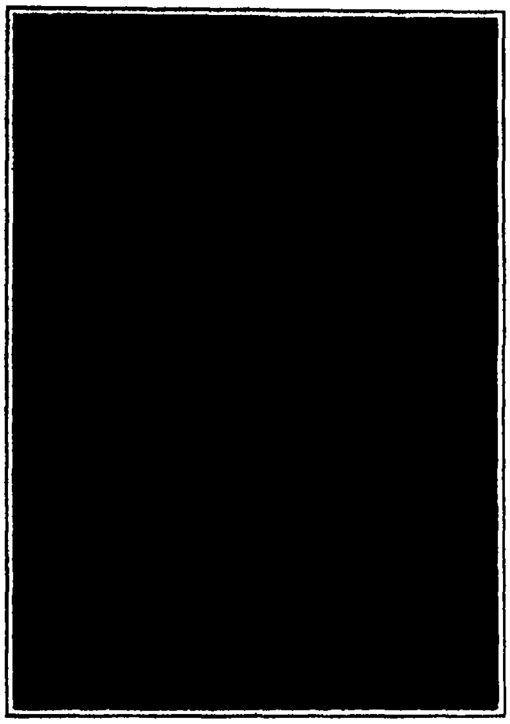
The third and rarest of the American Grues is the beautiful whooping crane (*G americana*) It is pure white in general color but the primaries are black and the bare portions of the head are reddish bordered posteriorly by a patch of blackish feathers The secondaries are curved downward and arch gracefully over the tail No doubt the great scarcity of this bird is due in part to reckless shooting but it seems probable that the invasion of settlers into its breeding grounds in the great middle territories of Canada, and the increasing cultivation along its migration route through the Mississippi Valley are hastening the inevitable extermination of this finest of American birds The numerical condition of a species in the wild state generally bears an exact ratio to the frequency with which it is met in confinement It is probable that the number of whoopers in captivity could be counted on the fingers of one hand It is unfortunate that this splendid crane cannot be induced to follow the example of the wood duck which is willing to save itself

THE BEAUTIFUL WHOOPING CRANE (G AMERICANA)



THE PARADISE CRANE (TETRAPTERYX PARADISEA)

from extermination by breeding freely in captivity Most of the wood ducks seen in American collections are birds bred in Europe! But cranes of most species are bred only on rare occasions, and then with great difficulty so there seems little to hope for from this source The Zoological Society is fortunate enough

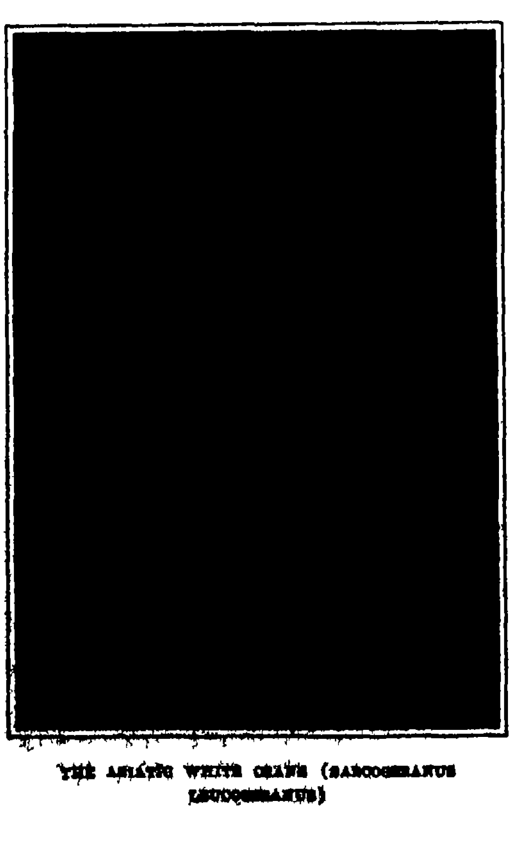


THE LITTLE BROWN CRANE (G CANADENSIS)

to possess a very fine whooper and it is hoped that he will be blessed with the usual longevity of his race

The Manchurian crane (*G japonensis*) is one of the most strikingly handsome of all the group It is very uncommon in captivity and now for the first time is represented in the collection Its general color is white as in the whooper but in this case the arched and pointed secondaries are black and the primaries white A slaty black band extends down each side of the neck the two joining on the nape The bird measures about fifty inches from tip to tip when fully extended It ranges from eastern Siberia to Corea and Japan in the last named island it was formerly held sacred and was allowed to be hawked by the nobles only The cranes depicted on Japanese screens are usually of this species

Next in systematic order comes the Asiatic white crane (*Sarcogeranus leucogeranus*) It is considerably smaller than the foregoing and is found from southeastern Europe to China and Japan It is white the primaries black and the head bare and reddish in color The immature birds of this species as well as those of the whooper have the white plumage infused with cinamon buff giving them a remarkable appearance This is one of those species most easily obtained alive and is brought to this country in some numbers It is quite hardy and easily tamable The specimen in the Zoological Park however has a temper so irascible that he cannot be approached with impunity and is no longer allowed the freedom of the large paddock.



THE ASIATIC WHITE CRANE (SARCOGERANUS LEUCOGERANUS)

Of the larger cranes the sarus (*Antigone antigone*) an Indian species, is most commonly seen in collections. It is the tallest of the order sometimes attaining a length of sixty inches Its color is a handsome French gray the overhanging secondaries closely approaching white the head and the upper part of the neck are bare and reddish the gray feathers of the lower neck being bordered above by a band of white The sarus is a most vigorous bird and inclined to be dangerous when associated with smaller and weaker species its height strength and an uncertain temper make it a companion to be feared

One of the rarities of the collection is the white-necked crane (*Pseudogeranus leucauch n*) This is a medium sized bird of a beautiful shade of gray with the throat and the posterior portions of the head and neck white the gray of the shoulders commencing at a sharp line The anterior part of the crown is bare and reddish The long and falcate secondaries which are very light in color are curved less abruptly and hence more gracefully than in some other species It is found in eastern Siberia, Corea and Japan and is very seldom imported alive In captivity it is quiet and docile showing a most pleasing absence of the pugnacity so frequent among its congeners

A crane of unusual and handsome appearance is the Stanley or Paradise (*Tetrapteryx paradisea*) It is a bird of fair size ranging throughout the southern portions of Africa where it is fairly common In color it is a uniform slate becoming practically white on the head the feathers of which are so lengthened as to give it a strangely swollen effect The drooping secondaries reach the height of their development and beauty in this species The Paradise is a very desirable bird for the aviculturist, for both its docility and beauty it is imported very infrequently

In captivity the crane most frequently seen is the dainty Demoiselle (*Anthropoides virgo*) It is the smallest of the family as well as the most widely distributed since it breeds in southern Europe and central Asia and spends the winters in southern Asia and northern Africa. Its general color is the conventional gray set off by the elongated black feathers of the breast, those over the eyes being drawn out into lateral tufts of silky white The demoiselle is brought to the United States each year in scores for the demand for it is great Its small size reduces its capacity for mischief even if its usually even temper should allow it to fall from grace its engaging ways excite the admiration of all who have opportunity to observe them This crane is willing to breed in confinement and has done so in this country on at least two occasions

The crowned crane (*Balearica pavonina*) of western Africa, differs from all the others in the possession of an occipital patch of straw like plumes from which it derives its name It is a handsome bird the blackish slate of its body plumage being contrasted by white wing-coverts and chestnut secondaries The sides of the head are bare and colored white above and pink below there are two small pinkish wattles on the throat. This crane is uncommon in America very few having been imported It is long lived and attractive and not so determined a root digger as most others but its temper among the society s specimens at least, is decidedly choleric

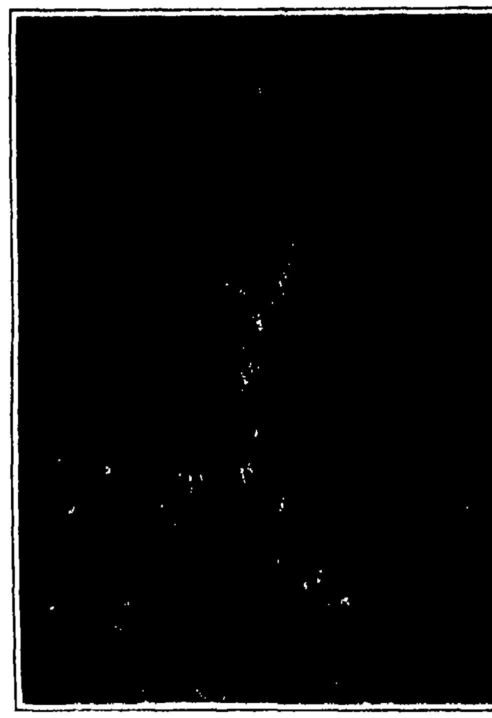
All of the cranes nest on the ground usually in marshes or on open plains forming their nests of grass and rushes The eggs are generally whitish or buff in color double-spotted with yellow or brown blotches and commonly two in number

Young cranes are most precocious being able to run about quite freely soon after hatching For a short time before the youngsters commence to forage for themselves their food consists mainly of insects brought to them by the old birds The parent birds are very devoted to their offspring caring for them with great solicitude and guarding them valiantly against intruders If an attempt to breed cranes in captivity is to be made a large grassy run should be provided for the exclusive use of the family as anxiety for the welfare and safety of the chicks is apt to make the parents over zealous in the treatment of the others in the same corral

An adult crane is a formidable antagonist not to be despised even by a man Frequently some members of the collection are so savage that they must be isolated, and the keeper must then continually guard himself against attack The crane stretches his long neck to the uttermost, and without hesitation makes frantic thrusts with his powerful beak so swift and certain that the eye can scarcely follow the movement.

An interesting characteristic of cranes is their habit of indulging at frequent intervals in grotesque dances which may be performed by an individual or by a group in graceful unison The leader starts off leaping and bowing with broad wings widely expanded, now seizing a leaf or bit of stick, now tossing it aside in capricious disdain The spirit of the dance is infectious and instantly the enclosure is a turmoil of leaping bobbing birds each striving to outdo the others in extravagance of gesture and motion

Most of the species are provided with lusty voices which they delight to use with great freedom However the tones which are clear and trumpet like are far from disagreeable and detract nothing from the performer s eligibility to a favored place in the list of captives



IL SANDHILL CRANE (G MEXICANA)

Animal Husbandry

EXPERIMENTS in breeding carriage horses has been continued in Colorado and Morgan horses in Vermont. The Colorado stud now has 71 animals the Vermont stud 30 Several additional zebra ass hybrids have been produced those now in their second year are larger than their dams though not as large as their sires That beef production may be a profitable business in the South when the cattle tick has been eradicated is shown by feeding experiments in Alabama now in progress for six years Feeding experiments with poultry indicate that fowls will not readily eat a ration containing more than 30 per cent of cotton seed meal and no harmful effects have resulted from such a feed Studies of the egg trade show that better methods of handling will greatly reduce the losses

The Secretary of Agriculture suggests that in order to secure the 2 000 or 2 500 horses now needed by the army every year 100 stallions should be owned by the Government and arrangements should be made for securing mares of proper type the War Department to have an option on the purchase of the foals

THE DEMOISELLE CRANE (ANTHROPOIDES VIRGO) THE SPECIES MOST FREQUENTLY SEEN IN CAPTIVITY

New Theories of the Evolution of Stellar Systems

Successors of Kant and Laplace

By F W Henkel, B A., F R A S

During the last f w years the researches of Chamberlin F R Moulton and See on the evolution of our system have greatly shaken the faith of astronomers in Laplace s well known Nebular Hypothesis More than a century ago Laplace who more completely than any other had worked out the consequences of Newton s theory of gravitation to the satisfactory explanation of almost every known feature of the motions of the planets developed a hypothesis previously proposed by Swedenborg Wright and the great philosopher Kant The solar system consists of a number of bodies arranged in an orderly manner all moving in nearly circular paths round the central body these paths being all nearly in the same plane and their motion in the same direction while there is a fairly regular progression of distances from the sun (Bode s Law) and the bodies are either spherical or spheroidal These features are by no means a necessary consequence of gravitation and seemed to imply an original connection or common origin Laplace supposed that at one time the matter now forming the sun earth and other planets was in the form of an intensely hot gas perhaps hotter than the sun is now This mass was of approximately spherical form and rotated slowly on its own axis the rotation becoming swifter as the mass grew colder and contracted In time rings of matter would be left behind the main mass (not thrown off as is sometimes stated) each of these rings would gradually collect into a single globe and thus the planets would be formed A planet thus formed continuing to revolve might itself abandon rings in contracting these rings would form into the satellites The rings of Saturn were at one time thought to be examples of this process but we now know that they are composed of swarms of meteorites rather than of continuous substance Plateau devised an experiment illustrating this formation of rings He prepared a mixture of alcohol and water of a specific gravity as nearly as possible equal to that of oil Some oil was then poured into the mixture As the bottom of the mixture was slightly more dense than the oil and the top slightly less dense the oil sank half way and floated in the middle as a round ball By means of a disk attached to a wire the ball of oil was set rotating The effect of the rotation caused the oil globe to expand into the form of a spheroid flattened at the poles and this flattening increased with the speed until at last a ring was formed which revolved round the globe After a time the ring broke up and gathered into a smaller globe which rotated besides revolving round the large globe

Laplace supposed that the rings would rotate as though solid their outer edges thus moving more swiftly than the inner and thus the planets formed therefrom would rotate in the same direction The exceptional cases of our system—the fact that the satellites of Uranus and Neptune move in the opposite direction to that in which most of the other members do and the swift revolution of the inner satellite of Mars—cannot be explained by this form of the hypothesis

M Faye however by modifying the original idea of Laplace and supposing that the planets were formed by local condensations (not by the detachment of rings) within the revolving nebula and that the outer planets Uranus and Neptune have been more recently formed than the rest has shown that these bodies would have retrograde rotation on their axes which he supposed to be the case from the motion of their satellites Since however Saturn s rotation is in the same direction as that of our own earth and eight of its satellites move in one direction but the last discovered (Phœbe) moves in the opposite direction we have still a difficulty unless we suppose this body to be a recent capture and not an original member of the Saturnian family The same thing is the case also with the eighth satellite of Jupiter whose motion is retrograde while the other seven have direct motion Prof Sir George Darwin by his theory of tidal evolution has attempted to explain the swift motion of the inner satellite of Mars the fact that the moon always turns the same face toward the earth and that the rotation period of Mercury (and probably that of some of the satellites of Jupiter and Saturn) is the same as that of its revolution He has given reasons for thinking that in former ages the period of rotation of Mars was much shorter than at present but that by tidal action of the sun this period has been gradually lengthened to its present value at the same time the satellite s period is supposed to be shortening and its distance from the planet slowly diminishing In the case of the moon he considers that millions of years ago our earth was rotating much more quickly than at present In contracting a portion separated from the rest and gradually receded becoming the moon The earth s tidal action upon the latter has resulted in the periods of rotation and revolution becoming equal to one another The ancient Arcadians are said to have boasted that their race came into existence before the moon but they were probably unaware of the period they claimed for their ancestry (fifty-seven millions of years!) The observations of Schiaparelli having led him to the conclusion that the planet Mercury (which is the nearest known planet to the sun) rotates on its axis in a period equal to that of its revolution round the sun (88 days), Sir George Darwin considers this is due in a similar manner to the tidal action of the central body having lengthened the planet s period of rotation until the latter always presents the same hemisphere toward the sun just as the moon does toward the earth The same thing has been asserted of the planet Venus also but it still seems probable that the shorter period of 23½ hours determined by the early Italian observers is the true length of the day on the earth s twin sister

Further modifications in consequence of increased knowledge of actual existing nebulæ and the applications of the principles of energy and thermodynamics have been proposed from time to time and most supporters of the nebular hypothesis no longer believe that in its original condition the nebula was even at so high a temperature as that of the sun at present It is considered probable that the original nebula was largely composed of meteorites which by collisions during their gradual drawing together would grow hotter and hotter After a time the central mass would become an intensely hot white star Later on the loss of heat from radiation exceeding the gain from contraction and condensation the star would cool down and perhaps finally become a dark body like the companion to Algol The planets being smaller than the star or sun round which they revolved would cool down at a much quicker rate losing more heat from their surfaces and becoming non luminous bodies while their interiors would be still very hot Our earth and the inner planets seem to have reached this stage while Jupiter and Saturn appear to be still to a small extent self luminous Estimates of the past and future duration of our system have been formed by Lord Kelvin Helmholtz and others but the very various lengths of time given ranging from twenty to four hundred millions of years alone show that these periods are little more than rough guesses needing further knowledge to be of value The discovery of the properties of radium has enormously extended the probable future duration of the sun s heat "We have every reason to think says Arrhenius that the sun s chemical energy will suffice to maintain its heat during thousands of millions perhaps billions of years

In 1861 Babinet proposed the application of a criterion based on the mechanical principle of the conservation of areas He showed that if ω be the sun s angular velocity of rotation with radius r and ω_1 represent these quantities when the globe is expanded so as to have the radius r_1 then

$\omega r^2 = \omega_1 r_1^2$ [Moment of momentum a constant quantity for a system rotating freely and subject to no external forces]

or

$$C = \Sigma m r^2 \omega = \omega \Sigma m r^2 = \omega_1 \Sigma m r_1^2$$

Suppose now the solar nebula extending to the earth s orbit let us find its time of rotation We get for this

$$25.3 \text{ days} \left(\frac{23\,445}{109.5}\right)^2 = 3\,192 \text{ years}$$

For the case of Neptune whose mean distance is thirty times that of the earth from the sun the solar nebula when reaching to that distance will rotate in

$$25.3 \text{ days} \left(\frac{30 \times 23\,446}{109.5}\right)^2 = 2\,888\,533 \text{ years}$$

(These figures are taken from a paper by Dr See)

Applying this criterion to the case of the various planets and satellites of our system we find periods in every case much greater than the known periods of revolution of these bodies The earth revolves in one year about the sun Neptune in about a hundred and sixty five years Thus it follows that the 'hypothetical solar nebula could not have rotated with sufficient speed to detach the masses" when it extended to the orbits of the several planets, as Laplace supposed. The evolution of the planets by separation of rings of matter from the central condensation through rotational instability must therefore be abandoned It is, however possible that secondary condensation nuclei might be formed by gravitational instability within the gaseous nebula and this has been pointed out by Mr Jeans in papers which he has contributed to the Philosophical Transactions of the Royal Society

We turn now to the alternative hypothesis developed by the work of Prof T J J See He has recently pointed out that some remarkable anticipations of his views as to the action of a resisting medium were made by Euler in 1749 The essential features of this hypothesis are that the Solar System has been formed from a spiral nebula and that the planets have not been detached from the central mass through its rotation but have been captured or added on from the outer parts of the nebula The roundness of the orbits of the planets and satellites in general use is due to the action of a resisting medium which has reduced the size of their paths and well nigh obliterated the deviations from circularity Just as the planets have been captured by the sun s action so in like manner the satellites have been captured by their several primaries not detached by rotation of these latter The moon too was originally a planet which neared the earth and was finally captured and made a satellite The asteroids or minor planets between the orbits of Mars and Jupiter are the surviving remains of millions of small planets most of which have been swallowed up by colliding with larger ones though many are still moving in independent paths round the sun Our own earth frequently encounters some of these objects and we have then a more or less brilliant meteor shower" The satellites having been captured in this way it is not surprising that a few of them should revolve in the opposite direction to the rest It is also remarkable that the paths of Phœbe (Saturn s 9th satellite) and of the 8th satellite of Jupiter are much more oval than those of any other known satellites from which it would appear that the density of the resisting medium must have been very slight at the great distances from the planets at which they revolve The planetary rotations have also been produced by the capture and absorption of small bodies and thus the larger planets Jupiter and Saturn should rotate most rapidly as is known to be the case

It has long been known that the effect of a resisting medium on the paths of bodies moving in it in a manner analogous to the planets moving round the sun is (1) to reduce their distances from the central body (2) to diminish the eccentricity of their orbits i e to make these more nearly circular

The proof of this is given in works on analytical dynamics (Cheyne s *Planetary Theory* and other books) and was of course well known to Laplace who says At the same time the planet approaches the sun by the effect of the resisting medium the orbit also becomes rounder The well known comet of Encké is thought to be gradually drawing nearer to the sun by such an action

Thus the present shape of the planetary paths is accounted for the action of the resisting medium having changed their orbits Around each planet circulates a vortex of cosmical dust and the descent of this material upon the surfaces of sun and planets is considered to give rise to the accelerations of their equatorial regions—i e the fact that the parts of the sun Jupiter and Saturn near their respective equators have a shorter period of rotation than those farther north or south However there is no perceptible difference of rotation in different regions of our own earth or of Mars so far as known and the amount of matter required to produce such an effect (at present) seems greater than can reasonably be supposed to fall upon the surfaces of the planetary bodies

A similar difficulty occurs in the meteoric theory of the sun's heat, attributing the latter to the impact produced by the fall of countless meteorites upon its surface. No doubt such bodies do fall upon the surface of the sun in considerable quantities, but the amount required to maintain the sun's output of heat is so enormous that there should be an enormously greater quantity in regions near the sun so that our own earth ought to receive nearly half as much heat as she gets from the sun by impact with meteors. This is certainly not the case

The descent of matter upon the sun increasing its mass may also account for the small secular acceleration of the earth indicated by the observations of eclipses, and the outstanding motion of the perihelion

of Mercury, which Leverrier attributed to a planet or ring of small planets lying between Mercury and the sun, may be also explained in this manner

The moon having suffered numerous collisions with smaller satellites has had its surface marked with the round sunken craters which are so distinctive a feature

So different a theory from the ordinary volcanic one however will not be easily accepted by selen ologists Prof See considers that the almost perfect circularity of Neptune s orbit shows that it cannot be the outermost planet of our system the roundness indicating that the nebulous medium was quite dense at that distance and consequently the limits of the system are much farther out Others planets lying beyond Neptune have been suspected and may yet be discovered by the telescope It is remarkable that Prof Forbes considers that one of these bodies whose distance he supposes is about a hundred times that of the earth from the sun and consequently would have a period of a thousand years (by Kepler s third law squares of periodic times as cubes of distances from sun $1\,000^2 = 1\,000\,000 = 100^3$) moves in a very eccen tric orbit whose plane makes a large angle to that of the ecliptic the resisting medium at that distance apparently having had little effect on its motion

The solar system in the opinion of Prof See was formed from a spiral nebula the latter arising from the meeting of two or more streams of cosmical dust The system began to whirl about a central point and thus gave rise to a vortex Great numbers of spiral nebulæ are now known to exist scattered out over the heavens millions of these objects being visible in the most powerful telescopes On the other hand it has been pointed out that there are very few nebulæ of the oblate spheroidal form such as the hypothesis of Laplace assumed to be met with in the sky Such nebulæ as we see have it seems a greater analogy with the solar corona than with the fiery condensing mists conceived of by Laplace (Proctor Old and New Astronomy § 1447)

The rotation period of Mars being about 24 hours 37 minutes and that of our own earth 23 hours 56 minutes Prof See considers that the period 23 hours 21 minutes for Venus obtained by the early Italian observers, is probably about its true value and thus the planet is habitable and probably inhabited by intelligent beings

It is well known that periodic comets probably owe their present position as permanent members of our system to the action of the planets When a comet coming from outer space in a parabolic orbit ap proaches a planet its motion is either accelerated or retarded In the latter case the parabola becomes an ellipse and the comet henceforth moves in a closed path around the sun always coming at each revolu tion to (or near to) the point where this retarda tion commences Thus arise the planets families of comets

A very large number of members of Jupiter s family of comets are known Halley s famous comet is a member of Neptune s family In a similar man ner it is supposed that the asteroids and satellites have attained their present positions The whirling of the gaseous matter of a spiral nebula is considered to be due to the unsymmetrical meeting of two streams or to the settling down of a nebula of unsymmetrical figure From this ultimately results a star surrounded by a system of planets and satellites The two oppo site branches of spiral nebulæ often seen on photo graphs represent the original streams of cosmical dust which are coiling up and forming spiral sys tems If the streams so converge that the nebulous mass becomes very concentrated the nebula may di vide at its center and give rise to a double star

This theory of the capture of the planets and the rounding of their orbits by the action of the resisting medium gives results in some cases the exact oppo site to those which are given by the theory of tidal evolution as investigated by Sir George Darwin

While tidal friction usually increases the major axis and eccentricity of an orbit the resisting medium as regularly decreases both elements In the actual physical universe both causes are at work together sometimes one influence preponderating and then the other With a large central sun and small planets as in our system the action of the resisting medium is most effective for systems made up of two large masses tidal friction is the predominating agency

There can be little doubt that these researches form a most important advance in our knowledge of the genesis of our system and though answers more or less satisfactory may be found to parts of the criti cism of Laplace s famous hypothesis yet we may fairly say that if not completely disproved it has been very seriously undermined

It is not to be supposed however that the alterna tive hypothesis is free from difficulties some of which have been slightly outlined but we may still say that it gives a reasonable explanation of many remarkable peculiarities Further evidence in its favor is no doubt wanted as well as spectroscopic proofs of mo tions derived from the study of actual existing spiral nebulæ Some recent work by Dr Nolke on the effect of a resisting medium in the evolution of the solar system from a primitive nebulous condition has been published by him at Berlin Sir George Darwin in his article on The Genesis of Double Stars gives an interesting historical account of work on the theory of the equilibrium of revolving liquid bodies by Poin caré Jeans and others together with an application of their results to stars of the Algol type Probably there is no subject more fascinating than the question as to the past and future of our system and though from our limited experience both in time and space there is the greatest necessity for caution in drawing conclusions yet the mind of man seems so consti tuted that it cannot help doing so It remains for the future to show whether the vast masses of ob servational data accumulated by the persevering in dustry of self denying men of science can be put together in the manner indicated above to yield the laws of stellar evolution —*Science Progress*

Cheese as an Article of Diet

A Food That is Much Neglected

WHILE experiments have established the facts as to some debatable questions concerning the comparative digestibility of green and cur d cheese perhaps the most valuable result has been in showing clearly the great value as food of all the more common varieties of cheese

The Swiss who are a very healthy people eat largely of cheese in fact bread and cheese form the greater part of the diet of many of them Many other European races eat largely of cheese The miners of England consume very much of the poor cheese made in the United States especially the high acid cheese using it extensively for seasoning and the Germans eat large quantities of the cheap but highly flavored skim milk cheese such as the hand käse which has perhaps the most pungent ordor of all the varieties of cheese made

In the matter of comparative food values it was thought that the results of the experiments given in this report made it safe to assume that cheese was as fully digested as most of the ordinary food materials which have been studied in earlier experiments car ried on in connection with the nutrition work of the Department of Agriculture It would in fact be un desirable for a larger per cent of any food material to be absorbed than was the case with the cheese

Heretofore cheese has seldom been regarded seri ously by consumers of any class in the United States as a possible cheap staple food All consumers of cheese with very few exceptions use it as a luxury in small quantities at comparatively rare intervals While in the aggregate a large quantity of cheese is eaten in the United States the quantity is neverthe less almost negligible when compared with some other products of less food value and inferior palat ability

The greater part of the cheese consumed in this country is eaten without any preparation while in many European countries the cheese is either sprinkled on other foods—vegetables usually—or is cooked with the food Americans evidently have much to learn from Europeans of some of the possibilities of preparing such dishes A number of European vari eties of cheese are made extensively and exclusively for use in connection with other foods or in cooking Among these is the well known Parmesan a hard cheese made from skimmed milk and also the sap sago cheese a small conical-shaped cheese made from skimmed milk and highly seasoned with herbs The Italians use cheese for flavoring as Americans use salt and pepper having it grated and constantly at hand in a small shaker With them macaroni with cheese is a common dish, as are other cheese preparations An excellent dish is the cheese omelet while warmed up potatoes can be mad very appetizing when cook d with cheese

It may be perhaps that the American people have gone so far in the consumption of only partly ripened and mild flavored cheese that the probability of learn ing to use cheese as a flavoring are very remote as it is only the well ripened or highly flavored cheeses that are satisfactory for flavoring purposes It is per haps a matter for some regret that so much mild flavored cheese has come to be us d as it is probable that much more satisfaction would be felt by con sumers in general with this great food product if they had learned to like the well ripened product with a well developed flavor It is generally conceded that people who like a highly flavored cheese never become tired of it

A comparison of the food value of cheese with that of other highly nitrogenous food materials may be of interesting value No kind of meat excepting dried beef carries such a large percentage of protein as cheese and as dried beef contains a much greater percentage of water the other food constituents aside from the protein are much less than is found in cheese Fresh beef as purchased has weight for weight little more than half the food value of cheese in either protein or fat and the same is true of prac tically all other fresh meats which have in many cases such a large percentage of refuse and in all cases such a large percentage of water that they are noticeably inferior to cheese in food value Bacon or fat pork are exceptions but their food value is mostly in the fat which can be and is replaced to a great extent by the carbohydrates of vegetables at a much less cost and sometimes perhaps at a benefit to the health of the consumer Fish and pork each have a notably large percentage of refuse while eggs have a high percentage of water To sum the matter up a pound of cheese has nearly the same food value as two pounds of fresh beef or any other fresh meat as food It is worth as much as or more than a pound of ham and is more digestible and it is equal to two pounds of eggs or three pounds of fish In price good cheese made from unskimmed milk costs about a third more than round steak and twice as much as the cheaper boiling beef while it costs practically the same per pound as smoked ham and bacon It costs usually a third more than fresh fish

Cottage cheese or cheese made from partially skimmed milk is cheaper even than the American or Cheddar cheese The first costs about one third as much and the partly skimmed product about two thirds as much as the so-called full cream cheese Practically the only food product that rivals cheese in food value and cheapness is dried beans

In view of the foregoing comparison of food values it is a matt r of som wonder why there is not more of a demand for cheese especially by people of lim ited means Estimates made by the Departm nt of Agriculture in the twenty second and twenty sixth annual reports of this bureau and in Bulletin 55 of the Bureau of Statistics show that the people of the United States consume between 169 and 185 pounds of meat annually per capita besides fish and poultry while the annual consumption of cheese is only about four pounds per capita Even granted that fresh meats are more palatable to most people some other explanation must be found for this wide difference in the quantity of the two products eaten A great pro portion of the laboring class in this country are able to eat plenty of wholesome food but they cannot af ford to discriminate against a cheap palatable and wholesome food in favor of a higher priced food The only way to account for the comparatively limited de mand for cheese is on the basis of custom and lack of knowledge People usually eat what they have been accustomed to making variations within narrow limits only and never changing the general character of their food New foods are not sought

In this connection particular interest attaches to the quantity of salt or cured pork products eaten in comparison with cheese Cured pork ham and ba con to about seven times the value of cheese are eaten annually No one can say that the pork prod ucts with the exception of good ham are more palat able than cheese and they are not known to be more healthful These pork products are usually eaten by the poorer classes who cannot afford to buy fresh meat but who could afford to buy cheese and cheese makes a better food in the dietary because of its high protein content

Cheese can no longer be discriminated against be cause of a suspicion that it is not a healthful food The absolute lack of any disturbance of the general health of the subjects used in th experiments re ported in this bulletin is proof that cheese can be eaten in large quantities without danger to health The Swiss cheesemakers also many of the Swiss farmers of southern Wisconsin eat unusually large quantities of cheese and they are noted for athletic attainments and physical endurance They brought the custom of eating cheese from their native coun try where cheese is a very important item in th diet The consuming public especially that part of it which needs to practice economy in buying food would do well to turn its attention a little more toward cheese since greater quantities can be used at a saving to the consumer —Abstract from Circular 166 Bureau of Animal Industry

The Use of Electricity in the Metallurgy of Iron

A Turning Point in the History of Iron

A turning point in the history of iron occurred in the sixteenth century when the increasing demand for iron led to the employment of water power to work the bellows of the blast furnace and consequently led to the location of iron works beside water falls The steadily increasing capacity of the bellows which was made first of leather afterward of wood and was not superseded by the iron cylinder pump until 1760 enabled the height of the furnace to be correspondingly increased the fuel (wood charcoal) to be better utilized and the temperature to be raised sufficiently to produce large quantities of fused pig iron containing much dissolved carbon instead of the small lumps of half fused malleable iron produced by the old low furnace with its bellows laboriously worked with the hand or foot

The invention of the steam engine made it possible to dispense with water power so that in the eighteenth century the iron industry began to leave the waterfalls and to seek sites convenient to the coal mines for the depletion of the forests made it necessary to employ coal or coke instead of wood charcoal Now barely 150 years after this second revolution the iron industry appears to be returning to the streams at least in regions abounding in water power and thus preparing for the day some 200 years hence when it will be necessary to economize the rapidly diminishing store of coal by obtaining from electrical energy produced by water power most of the heat required for the manufacture of iron

This is the opinion of Dr Prettner who gives in

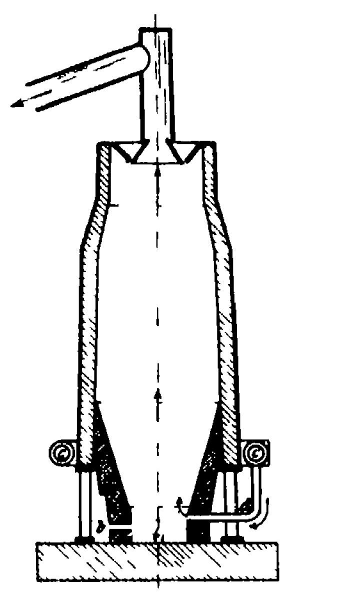


Fig 1 COMMON BLAST FURNACE

Ir mathcus the following comparison between electric and other iron and steel furnaces

Iron furnaces heated by coal or gas are of two classes blast furnaces in which pig iron is produced from the ore and the various furnaces employed in the transformation of pig iron into malleable iron and steel of different qualities For the present the same distinction must be observed in electric iron furnaces although it appears possible to produce steel directly from iron ore in the electric blast furnace Hence we will first compare the ordinary blast furnace with its electric rival and then make a similar comparison of refining and steel furnaces

The world's annual output of 50 million tons of pig iron is practically all produced in blast furnaces of the general type shown in Fig 1 The ordinary furnace of this type is 60 or 70 feet high and produces about 100 tons of pig iron per day but 300 tons are produced daily by each of the two largest German furnaces operated by the Krupps and the Rhenish Steel Works

The furnace is filled with alternate layers of coke (sometimes charcoal especially in Sweden) and of iron ore mixed with a certain proportion of limestone or other slag forming material As the mass settles down in consequence of combustion and fusion the furnace is replenished at the top and the operation continues without interruption for months or years The very high temperature estimated at 2 000 deg C (3 632 deg F) required at the bottom or hearth is obtained by a blast of air heated to 500 or 600 deg C (about 1 000 deg F) which is forced in through pipes called tuyères (*d* Fig 1) The carbon dioxide (CO_2) formed by the combination of the entering air with the glowing coke which it first meets takes up more carbon from the other layers and is thus reduced to carbon monoxide (CO) At the bottom of the furnace some of this carbon monoxide meets small grains of very hot but unmelted and very pure iron and is partially reduced to very fine particles of carbon, which unite with the iron to form a fusible com-

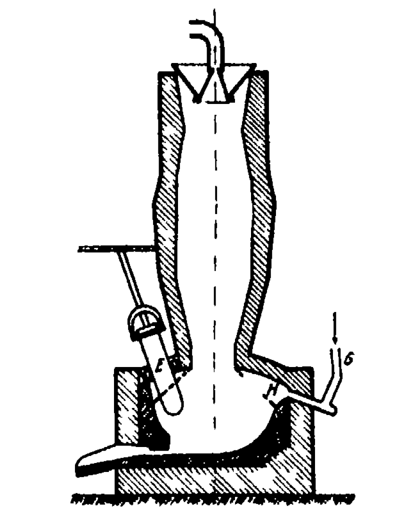


Fig 2—SWEDISH ELECTRIC BLAST FURNACE

pound containing from 3 to 5 per cent of carbon This compound known as pig iron, collects in liquid form at the bottom of the furnace, whence it is drawn off at intervals by tapping the furnace at the point *a*, and is run into sand molds, forming "pigs" The lighter fused slag is drawn off through an orifice at *b* Pig iron contains in addition to carbon varying quantities of manganese silicon phosphorus and sulphur which affect the quality of the iron and determine the methods by which it is converted into steel In the upper part of the furnace another portion of the carbon monoxide reacts with the heated ore (usually an impure oxide of iron) producing carbon dioxide and the pure granular iron already described The gas which escapes from the top of the furnace contains 60 per cent of nitrogen 12 per cent of carbon dioxide 24 per cent of carbon monoxide and 4 per cent of hydrogen and hydrocarbons Hence the mixture is combustible The combustion of one cubic meter of blast furnace gas produces 900 calories, or units of heat (Standard illuminating gas yields 5 000 calories per cubic meter) The gas is burned intermittently in towers or chimneys about 50 feet high containing numerous masonry barriers which store up the heat of combustion and subsequently communicate it to the hot air blast which is passed through the same towers Steam boilers are also heated with blast furnace gas

In its present stage of development the electric blast furnace appears puny and insignificant in comparison with its veteran adversary Canada, rich in ore and water power but poor in coal presents ideal conditions for the production of iron by electricity A Canadian commission experimented with Keller's electric furnace in 1904 and with Héroult's furnace in 1906 The experiments proved that all varieties of iron ore could be reduced by electricity that either gray or white pig iron containing only 1/100 per cent of sulphur could be produced at will by regulating the quantity of coke and that charcoal of inferior

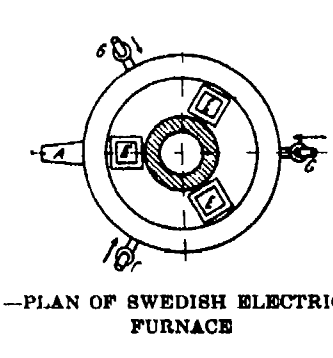


Fig 3—PLAN OF SWEDISH ELECTRIC BLAST FURNACE

quality could be employed (Gray pig iron presents a gray surface of fracture with distinct crystals of carbon in the form of graphite and contains a large proportion of silicon White pig iron presents a white fracture without visible particles of carbon, and contains a large proportion of manganese.)

The electric furnaces used in these experiments were of small height, open at the top and built of fire-resisting stone. The electrodes were blocks of solid or compressed carbon, one of which formed the bottom of the furnace while the other was suspended in the upper part.

Three Swedish engineers, Grönwall, Lindblat and Stalhane, independently of their French predecessors subsequently developed the first practical electric blast furnace in Sweden where the conditions are similar to those found in Canada This furnace was in continuous operation during three months in 1909, until it was stopped by a general strike The results were so encouraging that a 2 500 horse-power furnace capable of producing 7 500 tons of pig iron per year has recently been built and the erection of others is contemplated An ordinary blast furnace produces nearly five times this quantity but the electrometallurgy of iron is still in its infancy

The Swedish electric blast furnace (Fig 2) bears a general resemblance to the ordinary blast furnace It consists of a wide hearth 8 feet high surmounted by a narrower shaft 16½ feet high The various chemical processes which are distributed throughout the height of the common blast furnace here take place almost entirely in the hearth which is lined with fire-resisting magnesite and is arched above so that an annular space (*H* Fig 2) is left vacant above the cone of ore and coke which has descended from the shaft This space is essential to the durability of the furnace and its effect is increased by blowing in cooled furnace gas through the pipe *G* In the preliminary experiments the wall of the furnace was soon punctured at this point by its contact with the electrode and the hot contents of the furnace There are three electrodes of carbon about 5 feet long (*E* Figs 2 and 3) which penetrate the hot mass to a depth that can be regulated and are connected with a three-phase system of 25 periods and about 40 volts The currents traverse the poorly conducting mixture of

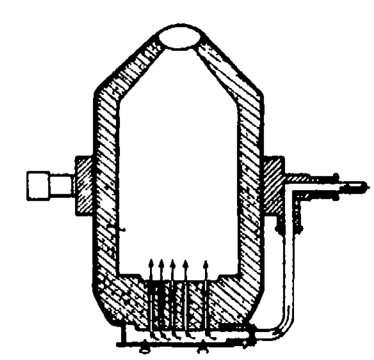


Fig 4—BESSEMER CONVERTER

ore coke etc and heat it so strong that the quantity of coke used need be only enough to deoxidize the ore and furnish the carbon of the fusible pig iron. Thus the large quantity of fuel required to maintain the high temperature of the reaction and to melt the iron and slag in the common blast furnace is here replaced by electric energy As no air is admitted, the furnace gas contains no nitrogen It consists of 40 per cent of carbon dioxide 48 per cent of carbon monoxide and 12 per cent of hydrogen and it produces, in combustion 1 750 calories per cubic meter nearly twice the heat produced by ordinary blast furnace gas This gas is cooled and blown into the furnace to cool the electrodes thus accomplishing a closed cycle It appears probable that by still further diminishing the quantity of coke and by other modifications a sort of crude steel can be produced in the electric blast furnace

The heat produced by 1 kilogramme (2 2 pounds) of good fuel can be furnished according to Stassano by 3 and according to Lowthian Bell by 4 horse-power hours of electric energy Hence in districts where 1 kilogramme of good coal costs more than 3 or 4 electric horse-power hours the electric blast furnace can be used with advantage This is the case in Sweden. In the German iron producing districts in Silesia, Westphalia and along the Rhine iron ore and coal are found so near each other and coal is still so abundant and cheap that electricity is not yet needed for the reduction of iron ore but even here the electric steel furnace has begun to claim attention

In order to describe intelligibly the considerable progress that has been made in the development of the electric steel furnace, we must first review briefly the current methods of producing steel and malleable iron The pig iron produced in the blast furnace is available for a few uses, as cast iron, but its impurities make it too brittle for most purposes It contains, according to the character of the ore and that of the ultimate product of which it is designed to serve as the raw material, the following percentages of impurities carbon 3 to 5, silicon 1/5 to 3, man-

ganese 1/10 to 6 or more sulphur to 1/2 and phosphorus to 3. Wrought iron contains from 1/20 to 1/2 per cent, steel from 1/2 to 1 8 per cent of carbon and neither should contain more than 1 per cent of silicon or manganese or more than 3/100 per cent of phosphorus or sulphur The function of refining and steel furnaces is to reduce the impurities of pig iron to these permissible limits

The classical types of modern steel furnace are the Bessemer and the Siemens Martin

The Bessemer converter invented in 1855 (Fig 4) differs from all other refining furnaces by being hung on trunnions so that it can be emptied by tipping and also by employing no fuel except the superfluous carbon of the pig iron which is poured into it in the fused state at a temperature of about 1 300 deg C (about 2 400 deg F) The converter is made of iron and is lined with quartzite The charge having been introduced compressed air is forced through a pipe which passes through the outer part of one trunnion and terminates in a chamber at the bottom of the converter whence the compressed air flows through a number of passages in the bottom lining and bubbles upward through the molten pig iron burning out most of the impurities particularly carbon silicon and manganese The heat produced by this internal combustion is sufficient to raise the temperature of the mass above 1 800 deg C (about 3 300 deg F) and to cause violent ebullition or spitting if the process is not carefully regulated By this operation the pig iron is converted into very pure malleable iron containing a small proportion of carbon In order to produce steel a quantity of carbon usually in the form of spiegel eisen a variety of cast iron which contains a large proportion of carbon is added toward the end of the process The entire operation including this recarbonizing' phase is accomplished i 20 or 2 minutes and yields from 10 to 15 tons of steel according to the size of the converter

In the Bessemer process the phosphorus of the pig iron is oxidized to phosphoric acid which cannot combine with the quartzite or silica, with which the converter is lined Thomas substituted a lining of lime and magnesia which absorbs the phosphoric acid and permits the employment of pig iron containing a large percentage of phosphorus The used linings form a by product known as Thomas slag which contains a large proportion of phosphoric acid and is sold as an agricultural fertilizer for a sum which covers a large part of the cost of the operation The introduction of the Thomas-Bessemer process in 1878 has given great value to extensive German deposits of iron ore containing so much phosphorus that it was formerly almost worthless and has saved millions of dollars which otherwise would have been expended for imported phosphates

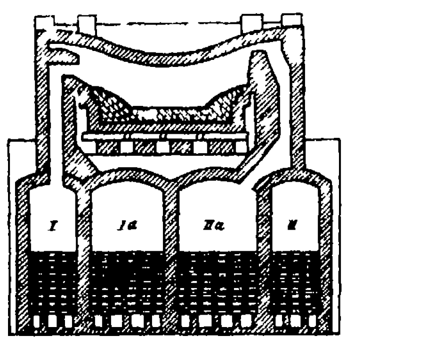


Fig 5—SIEMENS-MARTIN FURNACE

At present the Bessemer converter is employed less extensively than the Siemens-Martin furnace which saves the great cost of compressed air and also affords a means of utilizing the constantly increasing accumulations of scrap steel and wrought iron This scrap melted with varying proportions of pig iron in the Siemens Martin furnace yields Siemens Martin steel or malleable iron The furnace is of the open hearth type the iron being melted by a gas flame applied to its upper surface The gas is produced by the imperfect combustion of coal in special generators and is rich in carbon monoxide and hydrocarbons. The Siemens-Martin furnace (Fig 5) consists of the Martin furnace proper and four Siemens regenerators placed beneath it These regenerators are partly filled with masses of fire brick The coal gas and the air required for its combustion are first admitted to the furnace through the left hand chambers *I* and *Ia* (Fig 5) the larger chamber *Ia* forming the air channel while the hot product of combustion or furnace gas escapes through the right-hand chambers *II* and *IIa* After a time the flow is reversed so that the coal gas and air enter through the right hand chambers which have been heated by the hot furnace gas while the freshly formed furnace gas escapes through the left hand chambers By thus reversing the flow at intervals determined by experience the

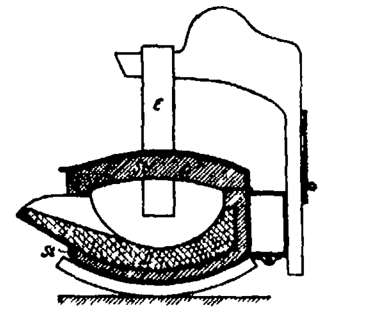


Fig 6—HÉROULT'S ELECTRIC ARC FURNACE

hot furnace gas is caused to give up indirectly to the coal gas and air a quantity of heat which added to the heat of combustion produces the very high temperature of 3 300 deg F which is required to melt wrought iron Recarbonizing is practised in the Siemens Martin process and various additions are made at different stages while the process is carefully watched and controlled by testing samples of the product. The ordinary Siemens Martin furnace produces 10 to 15 tons in 5 to 8 hours

The finest grades of steel used for instruments of precision etc have hitherto been produced in crucibles of 50 to 150 pounds capacity combined in large numbers in elaborate and costly furnaces which are also better adapted than the Siemens Martin furnace to the production of the nickel steel chrome steel and tungsten steel of which screw propellers and armor plates are made

Now all of these crucible steels and still finer grades can be produced with advantage in the electric steel furnace, the first cost of which is less than that of the crucible furnace and which can usually be operated cheaply by gas engines fed with blast furnace gas The electric process also is more flexible than any other A portion of the product can be drawn off at any stage and the remainder can be converted into steel containing less or more carbon or into nickel steel etc The electric furnace may also be allowed to freeze or become cold as the metal is not exposed to the air but is protected by a layer of slag so that it can be remelted at any time by turning on the current. If a filled Bessemer converter freezes it must be taken apart In the Siemens Martin furnace a frozen charge can be remelted but not without losing much iron in the form of slag Electro steel is superior to crucible steel in its absolute freedom from bubbles and sulphur and phosphorus streaks as well as in its forging qualities It also can be made from inferior raw material

In the direct electric process the material is both fused and refined in the electric furnace In the indirect process which consumes less current the crude fused product of a Siemens Martin furnace for example is run into the electric furnace and the substances required to effect the desired change in composition are added The choice between the two methods is governed mainly by the relative cost of coal and of electric energy

Electric steel furnaces are of three types Arc (Héroult Stassano etc) resistance (Girod) and induction (Kjellin) Héroult's arc furnace (Fig 6) appears to be the best of its class It is a vessel of heavy sheet iron thickly lined with fire brick (*St*) provided with a movable cover and so mounted that it can be emptied by tipping The bottom has an inner lining of calcined magnesian limestone *D* the function of which is to absorb the oxides of sulphur phosphorus and silicon Two carbon electrodes (one of which is shown at *E* in Fig 6) extend downward through the cover to within two inches of the surface of the fused metal The electrodes are moved as required by electric motors and are supplied with alternating current at 100 volts The heat required for fusion and refining is produced by the electric arc formed between these electrodes In the indirect process from two to five tons of crude fused steel according to the size of the furnace are run in from a tipping Siemens Martin furnace of the Wellmann type and are covered with iron ore The combined oxygen of the ore supplies the place of the free and too active atmospheric oxygen employed in ordinary steel making processes which oxidizes some of the iron and thus causes both loss and impurity The combined oxygen of the ore oxidizes only the sulphur phosphorus and silicon to their respective acids which are partly absorbed by the lime and magnesia below After 30 minutes the fused slag derived from the ore is drawn off and the surface of the fused metal is immediately covered with a calculated quantity of carbon This is covered in turn with lime which absorbs the remainder of the oxides of sulphur phosphorus and silicon A little manganese ore is mixed with the lime and the other required ingredients are added subsequently

Kjellin's induction furnace (Fig 7) is employed by the Krupps and several other German steel makers The fused metal occupies an annular trough surrounding a vertical bar electro magnet or transformer The primary coil of the transformer is fed with alternating current at 220 volts and the secondary coil delivers alternating current at 8 volts The secondary current is conducted through the metal in the annular trough where it produces sufficient heat to maintain the temperature of fusion In the direct process the trough is filled with solid pieces of crude steel cast iron etc which make such imperfect contact with each other that it is difficult to establish the current The difficulty is overcome by laying a steel ring in the trough or by leaving in it a small part of the preceding charge The subsequent operations are similar to those of the Héroult furnace

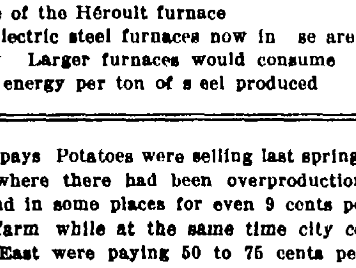


Fig 7—KJELLIN'S INDUCTION FURNACE

The electric steel furnaces now in use are of small capacity Larger furnaces would consume much less electric energy per ton of steel produced

No Well grounded Complaint Against the Farmer

After presenting many details with regard to the increase of prices on farm products between farmer and consumer the Secretary of Agriculture declares that the conclusion is inevitable that the consumer has no well grounded complaint against the farmer for the prices that he pays. The farmer supplies the capital for production and takes the risk of his losses his crops are at the mercy of drought, and flood and heat and frost, to say nothing of noxious insects and blight ing diseases. He supplies hard exacting unremitting labor A degree and range of information and intelligence are demanded by agriculture which are hardly equaled in any other occupation. Then there is the risk of overproduction and disastrously low prices. From beginning to end the farmer must steer dexterously to escape perils to his profits, and indeed to his capital, on every hand. At last the products are started on their way to the consumer The railroad, generally speaking, adds a percentage of increase to the farmer's price that is not large. After delivery by the railroad the products are stored a short time are measured into the various retail quantities more or less small and the dealers are rid of them as soon as possible The dealers have risks that are practically small except credit sales, and such risks as grow out of their trying to do an amount of business which is small as compared with their number

In continuation of this subject, the Secretary of Agriculture suggests that the problem of high prices is one for treatment by the consumer Why do not consumers buy directly from the farmers? he asks A distribution of farm products in this simple way has already begun in England where co-operative organizations of farmers are selling by direct consignment to co-operative organizations of consumers in cities. Farmers co-operative selling associations are numerous in this country but co-operative buying associations among the people of cities and towns are few Aside from buying associations maintained by farmers, hardly any exist in this country It is apparent, therefore, that the consumer has much to do to work out his own salvation with regard to the prices that he pays Potatoes were selling last spring in some places where there had been overproduction for 20 cents and in some places for even 9 cents per bushel at the farm while at the same time city consumers in the East were paying 50 to 75 cents per bushel although there was nothing to prevent them from combining to buy a carload or more of potatoes directly from the grower and for direct delivery

Many new forage crops from all parts of the world are being tested every year Only a few of these possess sufficient value to compete with the crops now grown Four such plants however recently introduced have given such admirable results that there can be little question that they will prove of great value Experience of the last three years has shown that Rhodes grass is especially adapted to the Gulf coast region In southern Florida three cuttings have been made during the winter months and as many as six during the entire season This grass has fine upright stems and good seed habits and should be extensively cultivated in this region

Airship and Aeroplane in War*

The Relative Merits of the Dirigible Balloon and the Aeroplane

By Lieut Frank P Lahm, U S A.

With both the dirigible balloon and aeroplane now in actual use in European armies it is not too early to compare the two types of air craft and draw conclusions as to which should be given the preference in equipping our own forces for equip them we surely must and will and that before long

First let us look into the different rôles to which air machines may be adapted in war In general, I would limit them to three: First and by far the most important, is reconnaissance, both strategical and tactical; second communication particularly on the field of battle third and last combat I will first take up the third rôle as it need occupy but little of our attention

The idea of dealing death and destruction in the form of fire and explosives dropped from the air of annihilating battleships, armies and cities has from the first appealed to the popular mind But let not the imagination run riot for experiments show that to produce its full effect the explosive must be confined A bomb dropped on the deck of a battleship would do little or no harm except to those of the personnel who chanced to be exposing themselves, and no projectile can be given sufficient impetus from an aircraft to penetrate steel and iron Furthermore experiments have shown that the chances of hitting the mark from an airship in flight are quite remote unless the craft approaches within a distance at which it would itself be exposed to extreme danger from the enemy's fire

The effect of dropping explosives on an army would be more moral than physical, for here again arises the difficulty of hitting the mark and moreover even if it were struck the effect would be limited to a small area and a few men

Dropped on a city explosives and inflammables would have an appreciable effect but stop and estimate the number of bombs and the number of aircraft required to carry them in destroying a city the size of one or our large seaports such as New York Boston or San Francisco

Communication on the field of battle these days of large armies and extended areas of combat has opened a large field of usefulness to aircraft Wireless and wire lines can now be utilized in connecting the different headquarters and subdivisions of an army on the field of battle but there must always be an element of unreliability and uncertainty in this method of communication It takes time to run wire lines, the headquarters to be connected are constantly changing their positions are often many miles apart and only a limited amount of wire can be carried Interference limits the number of wireless stations so but one station can send messages at a time. Then there comes times when telegraphic communication is not sufficient A map or sketch must be transmitted an insurpassable obstacle intervenes between two parts of the line, the commanding general wishes to visit in person some point of the line or to call a conference of his division commanders What better means than air machines which know no obstacle and travel in an air line, that is by the shortest and quickest route?

Reconnaissance is where aircraft will find their real sphere of usefulness For this they are pre eminently fitted and here we may expect to see those changes in strategy and tactics due to the appearance on the horizon of a new and powerful arm

Let us now look into the special qualifications and limitations of the different types of aircraft Then we can better draw a comparison between the dirigible and aeroplane and assign each to its proper sphere

The practical dirigible preceded the practical aeroplane by seven or eight years and gained a lead the latter has had to contend against ever since The first military dirigible the French Lebaudy No 1 which appeared in 1902 was a comparatively small machine with a capacity of 90 000 cubic feet one forty horse power motor and a speed of a little over twenty miles an hour in still air It was found that this was not sufficient to contend with the ordinary wind so the dirigible has gone on increasing in size horse power and speed until we now see monsters of the Lebaudy type such as the new 'Morning Post' owned by the British government It has a capacity of over 350 000 cubic feet and is capable of making a speed of over thirty five miles an hour Other examples of aerial Dreadnoughts are the 'Clément Bayard II' with a capacity of 250 000 cubic feet engines of 260 horse-power and a speed of thirty five miles; the Wellman transatlantic type which required 345 000 cubic feet of hydrogen to fill it; the Zeppelin rigid type of 150 000 cubic feet capacity

Among the advantages to be attributed to the dirigible are its weight carrying capacity and its adaptability for long cross country flights Hydrogen gives the lifting power and 1 000 cubic of this very light gas will lift 70 pounds The Zeppelin airships lift as much as 16 tons, and Wellman's dirigible with which he tried to cross the Atlantic Ocean had an ascensional force of over 12 tons The former has carried as many as forty passengers at a time and the latter besides its crew of six men was loaded with fuel and provisions sufficient to last ten days, the maximum length of time they expected to be in the air

On the other hand the dirigible has serious limitations which must be taken into account It cannot operate in a high wind for like a ship at sea, it must have headway to steer and maintain its course Winds as a rule are not steady especially those nearest the earth's surface A balloon capable of making thirty five miles an hour in still air would be helpless in a thirty mile wind for gusts exceeding thirty miles would be frequent, and five miles an hour is not sufficient headway to maintain a course into or perpendicular to a thirty mile wind Here however arises an advantage peculiar to the dirigible It is not dependent on its motors for its buoyancy and even were the speed of the wind greater than its own speed, it would simply have to ride out the storm then proceed to its port, and if the wind were blowing in the direction it desired to go, it would proceed under the double power of the wind and its motors, or should the latter break down it would be carried by the wind like a free balloon

The most serious disadvantage of the dirigible lies in its large size entailing great cost and numerous personnel, a large gas supply and above all, difficulty in maneuvering on the ground at the start and in landing The dirigible must operate from a fixed port where it can have a house to protect it at night or during a heavy blow and equally important, a supply of hydrogen gas which must be constantly added to maintain the form of the balloon and preserve its buoyancy Nearly all the serious accidents to dirigible balloons have occurred owing to difficulty in maneuvering on the ground A dirigible may be compared to a large sail, in some cases over 500 feet long When the wind strikes it, human power is not sufficient, so when the airship lands it must be promptly sheltered in a suitable house Various expedients have been resorted to for the purpose of anchoring a dirigible in the open and keeping its head into the wind but at best it will always be a decidedly hazardous undertaking In November, 1907 the French dirigible 'La Patrie' was caught away from its house broke loose in a storm and in spite of the two hundred soldiers holding it and after drifting across France England Ireland and Scotland floated out over the North Sea and disappeared In August, 1908, the 'Zeppelin IV while flying from Cologne to Lake Constance, was forced to make a landing near Stuttgart Germany A storm struck it shortly after tore it loose from its moorings, carried it into the air; an explosion followed, the airship fell to the ground and was reduced to a mass of tangled wreckage When the 'Morning Post' made its memorable trip, November 26th from Paris across the English Channel to the military headquarters at Aldershot, a distance of about 210 miles, in five and one-half hours the aeronautical soldiers were not able to hold it on landing and it drifted away A second attempt was successful but on towing it into the balloon house the envelope was torn and the gas escaped

The life of the dirigible is its gas supply Every day this must be replenished as an unavoidable leakage is constantly going on and air is constantly filtering into the gas, reducing its buoyancy and eventually necessitating a complete new supply Gas is generally provided in steel tubes loaded with hydrogen under high pressure at the gas factory and shipped into the field A 100-pound tube will carry 200 cubic feet of gas from which we can estimate for a 350 000 cubic foot balloon; 1 750 of these tubes weighing 175 000 pounds This would be sufficient to fill it once For each day it is inflated, an additional three or four thousand cubic feet will be required to replace the gas lost

Experiments have been made in firing at captive balloons anchored to the ground at fixed points, and it was found that shrapnel fired at mid or even long ranges, could bring them down No firing has been conducted at dirigible balloons in flight We know that it offers a large target and that a hole in the envelope allowing the gas to escape will bring it down but what are the chances of hitting this target? In reconnaissance it is necessary to operate at as low an elevation as three quarters of a mile which would be easy range for a high angled balloon gun, but when we remember the target is moving at a speed of at least twenty miles an hour and can constantly vary its altitude the difficulty of hitting it is very apparent

The aeroplane small compact, of comparatively light weight speedy easily handled both on the ground and in the air has all these advantages to adapt it to military purposes It is hardly safe to quote figures or records so rapidly are they surpassed—the wonder of yesterday becomes the commonplace of to-day and the marvels of to-day will be commonplace to-morrow Already the aeroplane has far exceeded a speed of mile a minute has risen to a height of more than 11,000 feet, has flown continuously without landing for over eight hours, has carried six persons and has demonstrated its ability as a cross-country craft. These are the performances of to-day; by to-morrow they may appear insignificant No other product of man's inventive genius has made such rapid strides in its early development. It is now just five years (December, 1905), since Wilbur and Orville Wright made the first human flight in a heavier-than air machine Now there are three hundred licensed aeroplane pilots in France alone and successful machines of different types too numerous to mention.

Perhaps the aeroplane's greatest advantage lies in its speed, for speed is the weapon with which aircraft combat their greatest enemy—the wind. With its great speed, it gains in manageability and invulnerability On October 27th, at Belmont Park, Long Island, we had the remarkable spectacle of aeroplanes 'flying backwards' On that day Johnstone and Hoxey while operating in a sixty mile wind, were carried away—one of them more than fifty miles. Both landed safely and returned the next day when the wind had subsided A year ago few pilots were willing to risk their machines in a twenty-mile wind—now no first-class pilot with a good machine hesitates to fly in a wind of twenty, thirty, forty or more miles an hour One of the next improvements we may look for in the aeroplane, is automatic control, which will largely eliminate the personal equation and skill of the pilot, and make it manageable, even under the most unfavorable conditions.

The vulnerability of the aeroplane need hardly be considered Though no experiments have been made, and we have no data, a consideration of the premises is sufficient to convince us that a small target like the aeroplane, flying at a height of three-quarters of a mile or more at an unknown speed of ten to one hundred miles an hour depending on whether it is traveling with or against the wind, constantly changing its elevation and direction, is a most difficult target to hit

The high speed of the aeroplanes has been cited as one of its disadvantages Some critics maintain it is impossible to observe accurately from an aeroplane moving at forty miles an hour They lose sight of the fact that at such altitudes a particular position is in sight long before it is reached and long after it is passed The aeroplane already has a slow record of less than twenty-three miles an hour By throttling down the engine and passing over a given point headed into the wind, the aeroplane can carry a skilled observer at such a rate of speed that he will have no difficulty whatever in carrying out his observations

The aeroplane has carried as many as six persons and can be built to carry more, but we shall never see it used as a means of transportation for large numbers or large weights, for in aeroplane construction, increasing the area by the square, increases the weight by the cube, that is, to double the size of the machine, it is necessary to triple the weight.

Now to compare the dirigible and aeroplane and draw conclusions as to their relative merits in warfare

From the point of view of manageability, both on the ground and in the air, the advantage is entirely with the aeroplane The day that Hoxey and Johnstone controlled their machines in a wind of more than sixty miles an hour, brought them safely to earth and later returned to Belmont Park under their own power, no dirigible balloon would have dared to leave its cover or had it been caught unawares in such a wind, it would have had to choose between an attempt to cross the Atlantic Ocean or landing with a certainty of being seriously damaged and probably wrecked.

A military dirigible carries a crew of about six men and on the ground requires *an entire company* to handle it The personnel for an aeroplane is one officer and ten men, which is sufficient to render it entirely independent The crew comprises an observer and two operators taken from the above personnel.

The cost, while a question of minor importance in time of war is not to be compared in the two types of machines The current price for a military aeroplane is \$5,000 to \$8,000 The price for a dirigible is more than a hundred thousand dollars The amount paid for a 'Clément Bayard II or a 'Morning Post,' or a Zeppelin would pay for fifty aeroplanes The upkeep of an aeroplane consists largely in oil and gasoline for the engine wood and cloth for repairs and the expense of maintaining one officer and ten men For the dirigible in addition to the same items for fuel, we must take into account the expense of maintaining an entire company and most important of all the gas supply Hydrogen gas as manufactured at present, costs from \$7 00 to \$10 00 a thousand cubic feet, simply for materials and power alone, without taking into account the expense of the plant and its operation, nor shipping the gas to the point where it is to be used

In manageability, both in the air and on the ground, in cost, in vulnerability in speed, we must accord the aeroplane the advantage In weight carrying, in long distance communication and in adaptability for wireless communication, the advantage goes to the dirigible From these relative advantages we can now assign each to its proper sphere

In the first place the dirigible must have permanent points of attachment, or bases from which it must operate, and to which it must return at short intervals for its gas supply, and especially for protection from the elements This condition leads us to eliminate it from field armies Permanent stations along the coast at various points along the main lines of communication inland should be established and equipped with dirigible balloons. Here they can operate from mixed sources of supply and, during invasion, would fulfill their rôles of strategical reconnaissance and long distance communication

But more important, let us first equip our field armies with aeroplanes, for it is on them we must depend for the last strategical reconnaissance, then for reconnaissance and communication on the field of battle and afterward for keeping in touch with the pursuing, or we hope, the retreating foe.

A group of aeroplanes should be attached to the headquarters of the army in the field. Each will re-

* Abstract of an article in the *Journal of the Military Service Institution*.

quire a personnel of one officer as observer, two skilled pilots, who will be non-commissioned officers, and eight other enlisted men capable of assembling, repairing and dismounting the machine. A housing of canvas is all that will be required, something that can be readily erected and taken down and can be carried on an escort wagon

On the field of battle, the commanding general will use aeroplanes to personally inspect any part of his command, to reconnoiter any position on his front or flanks, or through a combined reconnaissance of his en tire group of aeroplanes, can receive frequent detailed and accurate reports from all the subdivisions of his command, can know the enemy s dispositions and movements both at the front and on the flanks. No longer need his movements be timid or hesitating He knows where the enemy is concentrated. He knows where he is weakest—a rapidly transmitted order to each of his subdivisions enables him to concentrate at the most favor able point and to take full advantage of his adversary s weakness.

Each subdivision commander will depend on his aeroplane scouts to protect himself from surprise and to report to army headquarters the latest developments in his front.

Other first-class powers are not neglecting this new factor in warfare We do not know who our next opponent will be, but if it is a first-class power we shall surely find it with a trained and equipped aeronautical auxiliary Let us have a sufficient number of aeroplanes, of skilled operators, of trained observers, so that we can take the field on an equal or better footing for aircraft must be opposed by aircraft and the ad vantage to be gained by the use of these machines will go to the side which has the largest number and the speediest, and which makes the boldest and most skillful use of them

A Convenient and Inexpensive Furnace for Very High Temperatures

By D F Calhane Ph D

In an article by Pip in the August 15th, 1910, num ber of the *Zeitschrift fur Elektrochemie* is described a small furnace for high temperature work

It occurred to me that a description of a furnace that I have used for the past two years in my laboratory might be of interest.

Some two years ago, in connection with work on nickel alloys, I had occasion to employ high temperatures, over 1,500 deg C (2 732 deg F) It was especially desired to obtain the melts without carbon contamination In the furtherance of this work the following simple and efficient furnace was devised:

Referring to the figure

A shows the end of two fire-bricks Four of these were employed to form the outside of the furnace The two end bricks were cut down to give the proper width to the body of the furnace

C represents the cross section of a small fire-clay muffle, such as is sold by the Buffalo Dental Company in connection with its No 40 Fletcher's crucible furnace This sits inside the inclosure formed by the fire brick and the extra space is filled with a heat insulating composition composed of Portland cement, magnesium oxide and powdered asbestos This is shown by *B* in the figure.

At the bottom of the muffle is placed an alundum block *D* On this rests a No. O graphite crucible, shown by *G* in the figure

In this graphite crucible is cast an alundum lining, which keeps the melts from carbon contamination

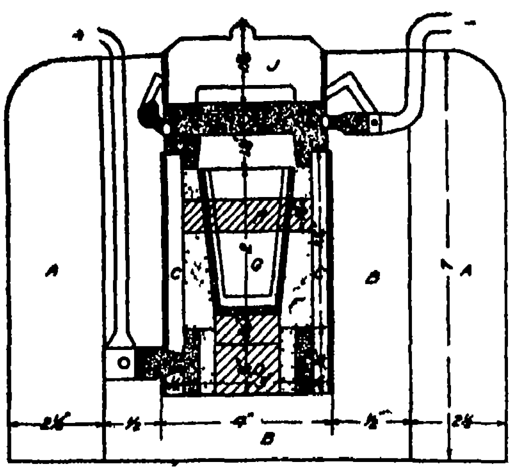


DIAGRAM OF VERY HIGH TEMPERATURE FURNACE

- *A* Fire Brick
- *B* Portland Cement, Magnesia Oxide and Asbestos
- *C* Fire Clay Muffle Iron Band
- *D* Two Alundum Blocks.
- *E* Carbon Ring
- *F* Powdered Carbon
- *G* Alundum Lined Graphite Crucible
- *H* Alundum Insulating Ring
- *I* Graphite Ring
- *J* Fire Clay Cover

The current enters by the lead at the bottom of the furnace, and is evenly distributed by a graphite ring *E*, that fits flush at the bottom of the muffle This ring was cut from an odd end of a graphite electrode The graphite electrodes lend themselves to this kind of work, as they are easily machined, whereas carbon is not.

The carbon resistor is denoted by *F* This is com posed of carbon powder obtained from the National Carbon Company *H* is an alundum ring that is dough nut-shaped. The inner hole is filled to within about one-quarter inch around by the crucible.

This design gives a simple method of insulating the main portion of the resistor, and directs the current flow along the walls of the crucible up through the ring between the walls of crucible and inner edge of the ring Herein lies the high efficiency of the furnace Intense heat is concentrated where it is wanted namely on the walls of the crucible By varying the area of the space between the crucible and the inner side of the ring, and the height of the block *D* the voltage and wattage of the furnace can be varied widely

On the top of the muffle sets a graphite ring *I* also made from an electrode end This ring has contacts screwed in as shown, connected with the leads for the exit of the current

On the upper edge of the ring sits the cover of the muffle *J* The top from the upper surface of the fire bricks over to the edge of the cover *J* is built up with the same insulating mixture used at *B* and is fash ioned to give a symmetrical outline to the furnace The whole outside may be painted with a water white to give a neat appearance The whole body of the fur nace rests on a cement base that is contained in a shallow, oblong box The furnace can be thus carried about as the whole thing weighs only about 25 pounds

A couple of examples showing the efficiency of the device may be of interest

In one case the heat resistivity of the device was pushed to the limit For this size of furnace 1,330 watts were found to produce a temperature that fused alundum and must have been over 2,500 deg C (4,532 deg F) In this experiment the furnace absorbed 70 amperes at 19 volts

In another instance the furnace was calibrated with a platinum iridium thermocouple and galvanometer up to the limits of this apparatus namely 1 660 deg C (2 912 deg F)

The results showed that at 700 watts a temperature of 1 660 deg C (2 912 deg F) was recorded by the pyrometer A rough extrapolation on this basis to 1,330 watts would indicate a temperature in the neighborhood of 2,800 deg C (5 072 deg F)

It might be asked how such a temperature could be attained without melting down the alundum com pletely The answer is that the intense heat zone is only along the walls of the crucible where no alundum is directly in contact.

A furnace on the above lines of 6 kilowatts capacity will soon be in use

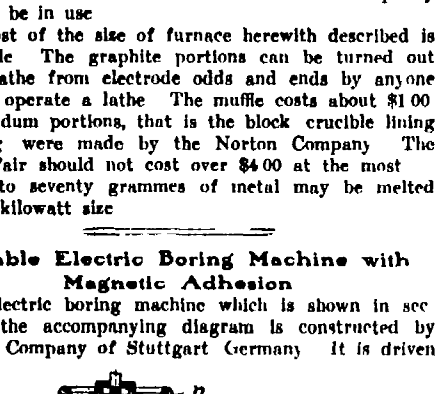
The cost of the size of furnace herewith described is very little The graphite portions can be turned out on the lathe from electrode odds and ends by anyone who can operate a lathe The muffle costs about $1 00 The alundum portions, that is the block crucible lining and ring were made by the Norton Company The whole affair should not cost over $4 00 at the most

Sixty to seventy grammes of metal may be melted in the 1 kilowatt size

* *Metallurgical and Chemical Engineering*

Portable Electric Boring Machine with Magnetic Adhesion

The electric boring machine which is shown in sec tion in the accompanying diagram is constructed by the Fein Company of Stuttgart Germany It is driven

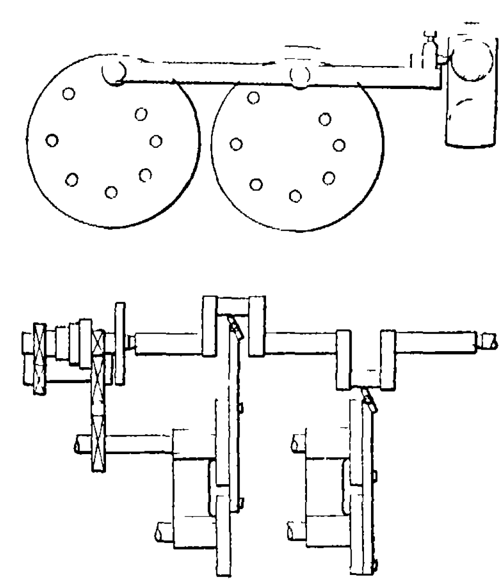


PORTABLE ELECTRIC BORING MACHINE WITH MAGNETIC ADHESION

by a small electric motor *m* by means of the bevel gear *e* The boring tool is advanced as the work progresses, by the pressure of the spiral spring *r* the ten sion of which can be regulated by the wheel *v* At the same time the machine is pressed forcibly against the plate by the attraction between the latter and the poles of the electromagnet e_1 e_2, which closely embrace the boring tool (This action occurs only with plates of iron or steel, for which the machine is designed) The machine is easily operated in any position. It is only necessary to suspend it from a convenient support to apply the tool to the place to be bored and to close first the circuit of the electromagnet, and then that of the motor The work of attendant is confined to watching the operation and turning the tension wheel *v* from time to time as the work ad vances – *Le Génie Civil*

Crank Turning Device

Patents have been applied for in Great Britain for the device working on the principle shown in the line engraving herewith intended for turning crank pins, and pieces rotating around a central shaft in a similar manner In the upper part of the figure, the general principle of the device is indicated, the lower part being a plan view showing diagrammatically its con nection with the lathe to which it is applied The principle of the device is easily seen from the illus tration The crank shaft is mounted on its own cen ters in the lathe and the working tools are given a reciprocating motion vertically and horizontally so as to coincide with or follow the motion of the work being turned The motion of the tool is positive and interdependent of the motion of the crank or shaft In the lower part of the engraving the device is



CRANK TURNING DEVICE OF NOVEL DESIGN

shown in two positions first when operating on one and then when operating on the other crank pin of a crank shaft having two pins While not shown in the engraving, the two disks to which the tool holder arm is connected must be positively geared together, as otherwise difficulties are sure to be encountered. To what extent a device of this kind will prove practical for the purpose for which it is intended it is difficult to say –*Machinery*

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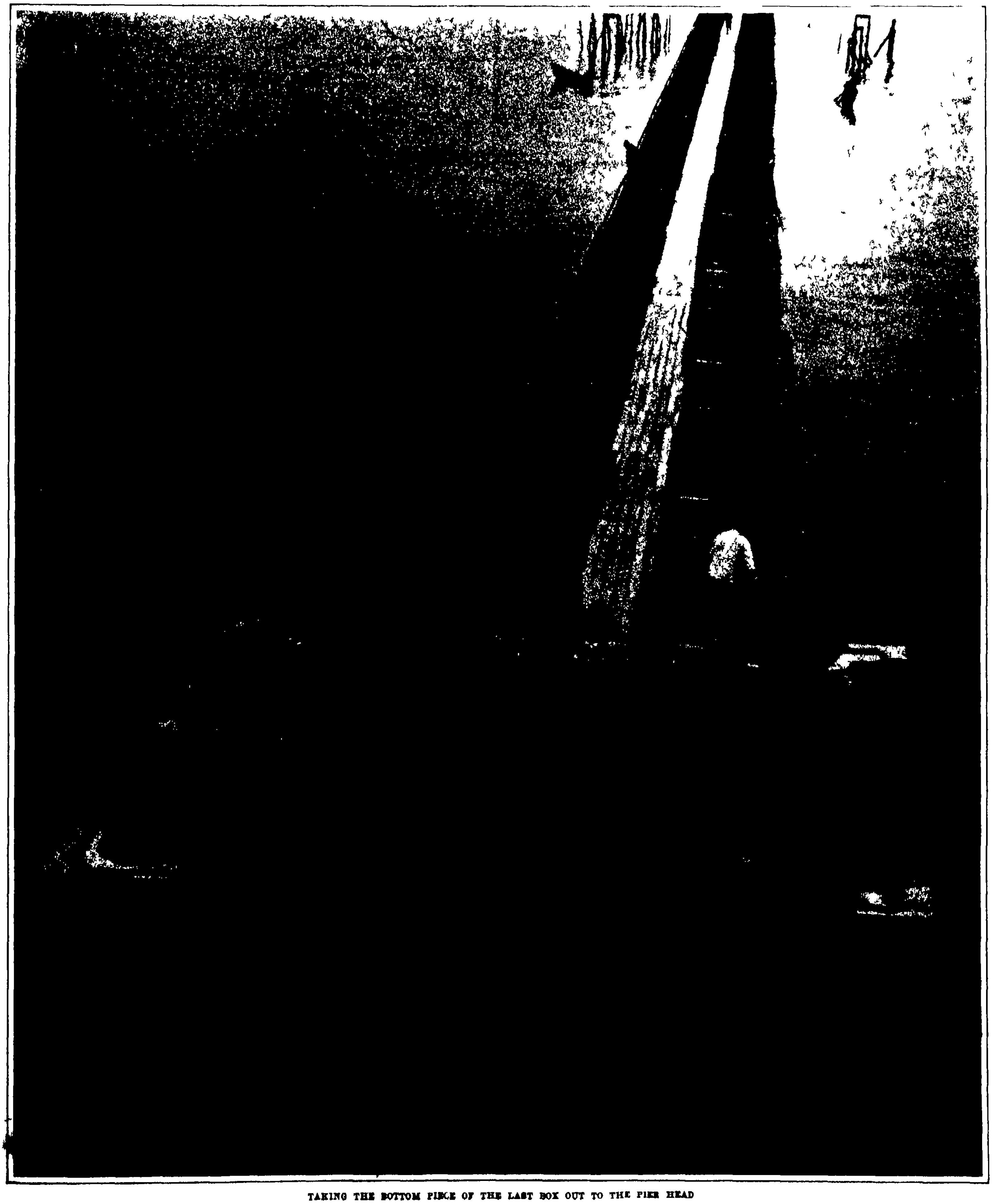


TAKING THE BOTTOM PIECE OF THE LAST BOX OUT TO THE PIER HEAD

BREAKWATERS ON THE WEST COAST OF JUTLAND.—[See Page 216]

The Preparation of Gas for Balloons*

What Chemistry Has Done for Ballooning

By A. Sander

Technical chemistry has contributed a very important share to the successful development of aerial navigation within the past few years, for a number of products of chemical industry function as important auxiliaries in the construction and operation both of dirigible balloons and of aeroplanes. It is only necessary to call to mind the several special steels and the light aluminium magnesium alloys which are of the highest importance as materials of construction for aeronautical purposes, or the India rubber used for impregnating the light and yet highly resistant and tough gas proof balloon fabric; there is also the *very important item of gasoline and oil* on the proper chemical purification of which the safe operation of the motor depends in a large measure; lastly there is the important problem of the production of the balloon gas, which places before the technical chemist a number of difficult problems for solution. Just as in a flying machine the motor is the vital point, so in ballooning the preparation of the buoyant gas is of fundamental importance.

Before turning to the consideration of the technical production of the balloon gas, it will be well first of all to briefly call to mind its purpose and the requirements which it is called upon to fulfill. The purpose of balloon gas is of course to lift a car, which together with its passengers, ballast and apparatus has a considerable weight. The dimensions of the balloon and car must be so chosen that the weight of the entire system is less than that of the air displaced thereby. Hence the first demand laid upon balloon gas is that it shall be very light as compared with air. This however is not by any means the only condition which has to be satisfied. The ideal balloon gas, which unfortunately is as yet but an ideal, should in addition to low density possess the following properties. It must not attack the balloon envelope and should be incombustible, in other words it should be chemically inert. Furthermore it should be as little as possible affected by changes in temperature, it should be readily liquefiable, non poisonous, and last but not least it must be cheap. While a large number of gases might be cited which fulfill more or less satisfactorily the first condition, that of low density, when we strike from such a list all those gases which fail to satisfy one or other of the remaining conditions we are left with practically only three substances as having hither to been used for a balloon filling, and they are heated air, illuminating gas and hydrogen. We will briefly consider each of these in turn.

I. *Heated Air.*—The art of aerial navigation may be said to date from the year 1783, in which the Montgolfier Brothers made a public ascent in their home in Brittany by the aid of a paper balloon covered with linen and inflated with hot air. It is on record that these same inventors had in the first instance experimented with steam as a filling for the balloon, the idea being suggested to their mind by the sight of the clouds drifting in the sky. In point of fact steam would make a very fair gas for ballooning were it not for the impossibility of preventing its condensation. The Montgolfier hot air balloon had a number of obvious limitations. The fact that fire had to be carried on board placed the occupants in considerable jeopardy owing to the risk of the balloon itself being set in flames. Furthermore, the extreme height to which it could ascend was only about 8 000 feet, for in order to rise higher than this it would be necessary to heat the air above 100 deg. C., which could not be done without injuring the balloon cover.

II. *Illuminating Gas.* Of much greater importance than hot air for ballooning purposes is the use of illuminating gas. Its introduction into the art is usually ascribed to an Englishman, Greene, in 1818. It has however been demonstrated from old documents by Dutch chemists that illuminating gas was used as early as 1783 in their country, that is to say in the very same year in which the brothers Montgolfier made their first ascent.

At the present day gas works are the principal centers from which most balloon ascents take place, and the quantity of gas consumed for this purpose is rapidly increasing. A very brief resumé of the preparation of illuminating gas may here suffice, inasmuch as its mode of manufacture is more or less a matter of common knowledge owing to its extended use in everyday life. As is well known, illuminating gas is prepared by the dry distillation of coal. This process is usually carried on in fire clay retorts arranged in batteries of six to twelve in one furnace. The gas issuing from the retorts is passed through an elaborate and extended series of apparatus in which it is cooled and freed from certain impurities. The purified gas is collected in so-called gasometers, whence it is forced into the mains for general distribution. Illuminating gas is colorless, but readily recognized by its odor. It is not a chemical individual but a mixture of gases, its principal constituent, amounting to about fifty per cent, being hydrogen. The composition of the gas is somewhat variable, and in consequence its density also fluctuates between about 0.36 and 0.52 (expressed in the scale which gives to air the density 1). This corresponds to a *lifting power of 0.052 to 0.39 pound per cubic foot.* As regards density the requirements of balloonists and of the general consumer of illuminating gas are at variance, for as a balloon filling a light gas rich in hydrogen is the desideratum, while for illuminating purposes a gas rich in the heavier illuminants is more advantageous. Nevertheless there are few gas works in Germany whose product has density greater than 0.45. Heavier gas occurs only where exclusively silesian coal is distilled or where much water gas is added.

In the course of the distillation of coal the composition of the gas issuing from the retorts varies considerably, and especially toward the end of the distillation a very light gas rich in hydrogen is obtained. It has therefore been suggested to collect the last portions, which are of comparatively low illuminating value, separately, and to utilize them for ballooning purposes. This mode of procedure would however introduce considerable complication into the manufacture of coal gas, and has therefore found no application in practice. On the other hand a method which of recent years has been applied with much success consists in converting the purified gas into a lighter product by heating it at a high temperature. This process is not altogether a new invention. In the year 1894 Bunte and others had observed that by this treatment ordinary illuminating gas can be made to yield a product containing about 80 per cent hydrogen and having a density of about 0.2. The process was however not put into practice until very recently, when Dr. von Oechelhäuser gave publicity to the fact that a gas company in Dessau had succeeded in producing a special balloon gas by simply heating illuminating gas to 1 200 deg. C. The apparatus used is very simple. The gas is passed through highly heated retorts charged with small coke. At the temperature indicated the hydro-carbons are split up into their constituents, as for example

$$CH_4 = C + 2H_2$$

This change is accompanied by an increase in volume of 20 per cent, while the carbon is deposited upon the retort walls in the form of soot or graphite. The gas produced is passed through a small purifying plant and into a gas holder. The additional cost of converting the ordinary illuminating gas into balloon gas is just about the same as the cost of distributing the ordinary gas to consumers, so that the price of balloon gas at the works should be about the same as the price of illuminating gas at the point of consumption. The specific gravity of the balloon gas fluctuates between 0.225 and 0.3, with an average of about 0.27 and a *lifting power of about 59 pounds per cubic foot.* This corresponds to $26 to $34 per ton of lifting power (German conditions). The gas contains about 80 per cent hydrogen and only 5 per cent of methane. It is free from benzine and other hydrocarbon which would attack the balloon envelope. It has a very much weaker odor than ordinary coal gas and is much less sensitive to temperature changes.

While this process of making balloon gas represents a very considerable advance for the purposes of ordinary balloons, it is hardly likely that it will ever have any value for dirigible balloons. For on account of the great weight of such crafts it is necessary to employ the highest buoyancy available, so that the only gas which enters into consideration is hydrogen.

III. *Hydrogen.*—The lightest of all known gases is hydrogen, whose density compared with air is 0.07. It has the further advantage for ballooning purpose of being comparatively non-sensitive toward temperature changes. It is very hard to liquefy, hardly soluble in water and diffuses with great ease even through the smallest openings. This last is the reason why the attempts of the brothers Montgolfier to fill paper balloon envelopes with hydrogen were entirely unsuccessful. The physicist Charles of Paris, was the first to succeed in sending up a balloon filled with hydrogen. He prepared the gas by the action of dilute acid upon iron. The balloon envelope was made of silk taffeta. Although its volume was less than 1 400 cubic feet, it took three days and three nights to fill, and required no less than 1 100 pounds of iron filings and 550 pounds of acid. The method which Charles used for generating the gas was extremely wasteful of material. Coutelle's attempt to prepare hydrogen on a large scale by passing steam over red hot iron did not prove well adapted for large scale working. A great step forward was made by Renard and Giffard, who used the same reaction as Charles, but modified the process by feeding continually fresh quantities of acid to the iron while drawing off the iron sulphate liquor. In this way a much more complete utilization of the iron was secured. Nevertheless this process also represented an extremely costly method of preparing hydrogen. It was only toward the end of the nineties that a new source of hydrogen became available and almost completely drove out the old process. This new source is the electrolytic hydrogen produced by the Fabrik Griesheim Elektron, who produced large quantities of hydrogen as a by product in their electrolytic process of manufacturing caustic alkali. This industry has at the present day reached such a scale that the firm named above produces in its three works daily no less than 700 000 cubic feet of hydrogen. Although of late years the consumption of this gas has increased very greatly, as a matter of fact only a small portion of the gas is at present collected and compressed into steel cylinders at 120 to 150 atmospheres, while the bulk of it is discharged into the atmosphere. The placing upon the market of hydrogen from this source has done much to further the interests and development of aerial navigation in Germany. The electrolytic hydrogen possesses some very remarkable advantages owing to its purity and more especially its freedom from arsenic. This has led to the establishment of plants built especially for the electrolytic production of hydrogen on its own account, that is to say quite apart from the manufacture of alkali. For this purpose the electrolyte is simply water rendered conducting by the addition of a small percentage of acid or preferably alkali. The advantage of alkali is that its use permits the employment of iron vessels and diminishes the wear and tear of the electrodes.

While electrolytic hydrogen possess the advantages which have been referred to, it unfortunately presents at the same time rather severe drawbacks. Thus the number of costly steel cylinders required for a large production is quite excessive. Furthermore there is added to the cost of production, which it is true is moderate, the cost of compressing the gas, and there is obtained as a by product with every two volumes of hydrogen one volume of oxygen, an outlet for which must be found. Lastly the item of freight is very considerable, especially in view of the fact that the return of the empty cylinders represents practically the same expenditure as the first shipment of the charged cylinders. In view of the immense gas consumption of the modern air ship, such as for instance the Zeppelin type of fifteen thousand cubic meters (528 000 cubic feet) capacity, it has become imperative to look for a process of manufacture of hydrogen which would render it possible to produce large quantities of gas at moderate cost, and which would obviate the use of compressed gas and of steel cylinders. A process of this kind has been installed at Friedrichshafen by the Carbonium Company, based upon the splitting up of acetylene and other hydrocarbons into their components. The gases are decomposed by electric sparks into carbon and hydrogen in cylinders provided with stirring gear. The carbon which is deposited in the form of soot is the principal product, and it is claimed that the material so obtained is superior to that from other sources for the production of printers ink, paint, and other uses. No data are available at the present time as to the practical operation of this process, owing to the fact that a part of the works was destroyed by an explosion last July. Indications, however, seem to be that the process will represent a very economical source of hydrogen.

Another process, which has been worked out by the International Hydrogen Company of Frankfurt-on-the-Main, is based upon the reaction between steam and red hot iron discovered by Lavoisier. As has been mentioned above, an attempt to turn this to technical account had been made years ago by Coutelle, without success. The difficulty was to reduce the oxide of iron formed in the process back into iron, so as to restore

* Adapted from *Zeitschrift für angewandte Chemie*.

the raw material and render it available for further use It has been discovered that pyrites cinders are very well adapted for the process They are very porous and for this reason readily reducible to metallic iron by passing generator gas over them On leading steam over the reduced iron so obtained a very pure 98 per cent hydrogen is readily prepared

Another very promising process has been introduced by Siemens and Halske and starts from calcium carbide as raw material As is well known to every layman at the present day this substance when treated with water under ordinary conditions yields acetylene The inventors have discovered that the reaction proceeds along an entirely different course if the calcium carbide is treated with steam at red heat The formation of acetylene and other hydrocarbons is almost completely avoided and the reaction proceeds essentially according to the following equation

$$CaC_2 + 5H_2O = CaO + 2CO_2 + 5H_2.$$

From the mixtures so obtained the carbon dioxide can be readily extracted by passing the gases over some of the lime produced in a previous run The apparatus required is extremely simple and the raw material is cheap so that this process ought to find wide application

We now come to a group of processes all starting from the same raw material namely water gas This gas as is well known consists of a mixture of about 50 per cent hydrogen and 50 per cent carbon monoxide (C O) In practice the gas is contaminated with a certain proportion of carbon dioxide and nitrogen The density of water gas is 0 52 to 0 54 so that it might be directly utilized for balloon filling owing to its highly poisonous character however this would be very undesirable and dangerous

The first efforts to use water gas as a source of pure hydrogen date many years back At first the endeavor was to simply carry out the water gas process in such manner that only a small proportion of carbon monoxide was formed Tillard found that if an excess of steam was used the carbon monoxide was oxidized to carbon dioxide which latter can readily be eliminated from the mixture The reaction is simply

$$C + 2H_2O = CO_2 + 2H_2$$

It is however very difficult to carry this out in practice on a large scale and to-day the efforts in this direction have been practically abandoned It is now the general practice to start out from the finished product water gas and either to eliminate the carbon monoxide by absorbing agents or to introduce in its place an equal volume of hydrogen As absorbing agent cuprous chloride has been used but the product obtained by its means contains only 80 per cent hydrogen A considerably better result is obtained according to Frank and Caro by passing water gas through retorts containing moderately heated calcium carbide This reagent absorbs not only the carbon monoxide but also the carbon dioxide and the nitrogen There is thus obtained a very pure gas and in addition to this two valuable by-products namely graphite and calcium cyanamide A still simpler method of eliminating the carbon monoxide is by liquefaction This process also has been introduced into practice by Frank and Caro in collaboration with Linde The liquid carbon monoxide obtained as a by-product is utilized in a gas motor which furnishes the power for compressing the water gas Still another process has been worked up by the Chemische Fabrik Griesheim Elektron in which the carbon monoxide is replaced by an equal volume of hydrogen The principle on which this process is based is as follows When moist water gas is passed over lime heated to 500 deg C calcium carbonate is formed and hydrogen is liberated

$$CO + H_2O + CaO = CaCO_3 + H_2$$

In order that the product may contain as high a percentage of hydrogen as possible it is essential that the water gas be nearly free from nitrogen a condition which can be fulfilled by the use of specially designed generators Considering that this process makes use of only water gas and lime for its raw materials it ought to prove extremely cheap

Very similar to the preparation of producer gas is the oil gas process It consists in blowing oil instead of steam into a generator charged with red hot coke In this way it is possible to obtain directly a gas containing as much as 90 to 96 per cent of hydrogen A special advantage of this process is that the installation can readily be designed in transportable form being mounted upon two railroad trucks The importance of this for aerial navigation in military operations is very obvious although it may be necessary to carry the portability even farther than is possible with this arrangement As a matter of fact in the Boer War the English Army carried hydrogen in steel cylinders using camels as beasts of burden Each camel transported two bottles of 140 cubic feet capacity For the service of the English balloons having a capacity of 1 400 cubic feet a train of fifty camels was therefore required In the Russo-Japanese War the method employed by the Russian Army consisted in the generation of hydrogen from aluminium and caustic soda This reaction proceeds very rapidly rendering special cooling precautions necessary The method is of course very expensive Another process which is specially adapted for military purposes is based on the reaction

$$H_2O + Si + 2NaOH = Na_2SiO_3 + 2H_2$$

The special advantage of this is that only two kilograms of silicon are required for the production of one cubic meter of hydrogen This process was used by Spain in the Morocco campaign Lastly may be mentioned the production of hydrogen from calcium hydride a gray substance prepared by passing hydrogen over molten calcium This substance reacts with water liberating hydrogen according to the equation

$$CaH_2 + 2H_2O = Ca(OH)_2 + 2H_2$$

The production of one cubic meter of hydrogen requires the use of only one kilogram of calcium hydride The process has hitherto been used only for filling small pilot balloons but it would seem to be well calculated to fulfill the requirements of military practice

This concludes a review of the most important processes which have been proposed and carried out with some measure of success for the production of balloon gas It is impossible at the present time to judge which of the numerous methods proposed will ultimately prove the best But this can be said that the problem as a whole is well on the way towards solution and that the keen competition which is at work among the several processes now recognized as practically feasible will bring results in the near future so that we shall soon have at our command one or more thoroughly practical processes satisfying the various conditions imposed by the conditions of consumption

The Effect of Radium on the Higher Animals

Prof London's Researches

In 1903 Danysz observed that tubes containing radium introduced under the skin in the region of the brain or spinal cord produced symptoms of paralysis in three hours and tetanic convulsions in six hours The effect was greatest in the youngest animals Similar results were obtained by a different method by Prof London the celebrated Russian physiologist from advance sheets of whose forthcoming work on Radium in Biology and Medicine as reprinted in *Die Umschau* the following account is derived Prof London exposed mice to the radiation of 30 milligrams of radium placed above their cage within an inch or less of the animals On the third day of the exposure the mice became dull and sleepy and their ears became red On the fourth day these symptoms were more serious the hind legs became paralyzed and the animals died on the fourth or fifth day

In 1904 London exposed three rabbits to the action of radium in a similar manner During two weeks no morbid symptoms appeared On the sixteenth day the ears reddened and red spots appeared on other parts of the body These spots developed into ulcers which gradually healed Six or eight weeks after the beginning of the experiment the ears were almost entirely bald and the hair began to fall from the back The bald places then became inflamed and ulcerated After sixteen months the ears were greatly thickened and deformed and covered with crusts and the entire back was destitute of hair In the eighth month motor disturbances appeared The animals gradually lost control of their hind legs until finally they moved forward by means of their fore legs alone dragging themselves on their bellies with their hind legs trailing helplessly

The eyes were frequently examined and in all cases were found more or less affected The greatest changes were produced in the retina As death approached the eyes were generally quite closed and covered with a thick secretion The retina was not equally affected in all cases probably because the radium rays fell upon it only when the eye was directed toward the tube

For several months no effect on the sexual functions was observed and the female gave birth to three litters, in July September and November After wards the sexual impulse progressively weakened and finally vanished.

Despite the fact that the injurious influence of the radiation soon appeared the rabbits steadily increased in weight at first but they afterward lost weight very rapidly

London also investigated the influence of radium emanation on frogs and white mice Two frogs were placed in two 2-quart glass bottles containing a little water One of these bottles was connected for two days with a vessel in which emanation was being evolved and was then disconnected and corked After three days it was uncorked and allowed to remain open 48 hours and was then again connected with the radium vessel for 48 hours after which it was again disconnected and corked When the experiment was arranged in this manner the frog died three or four days after the second dose of emanation while the control frog in the other bottle remained in perfect health

The same result can be obtained by permanently connecting one of the bottles with the source of emanation In this method the successive phases of the effect can be followed more satisfactorily The morbid symptoms which begin to appear on the sixth or seventh day include sluggishness of movement sleepiness slimy appearance of the skin and difficulty in respiration which causes death on the thirteenth to fifteenth day The attitude of the frog and the appearance of the water are characteristic In the control vessel the frog stands in a normal manner on all fours and the water remains clear but in the vessel exposed to emanation the frog's head and chest are extended forward and the water is turbid

The frog exposed to the emanation exhibits a radioactivity which can be detected on the first day Very interesting experiments can be made in the dark with frogs killed in this way Thus it can be shown that the frog emits Alpha Beta and Gamma rays and photographs itself on a sensitive plate covered with black paper The imprint is most distinct when the exposure is continued three hours The most strongly radio-active portion is the skin If part of the skin is removed and the experiment is repeated the outline of the section removed appears distinctly in the photograph The blood was found very dark and the skin abnormally soft. The microscope showed extensive changes in the skin and spinal cord

In another experiment three or four suckling mice were placed in a bottle into which radium emanation had been admitted during 48 hours The bottle was then corked and the mice were left exposed to the action of the emanation for four hours after which the bottle was uncorked the mice remaining in it two hours longer The same number of mice of the same litter were placed in another bottle not containing emanation for comparison During the entire experiment and the two following days the mice showed no abnormal symptoms On the third day the mice which had been exposed to the emanations lay on their sides breathed with difficulty and died with symptoms of dyspnoea Death came most quickly in proportion to the length of exposure to emanation The cause of death is probably to be sought in a disturbance of respiration

Electricity from Falling Drops of Water

Some time ago A Schmauss showed that drops of water falling through ionized air take up a negative charge Seeliger experimenting with ordinary water in Munich found that in ordinary air no negative charge was gained and when ionized by Rontgen rays only a quite feeble negative charge was assumed To explain this Seeliger supposes a charge effect due to Volta p d The author in the present paper seeks to show that Seeliger's explanation is not tenable and further goes on to explain the cause of the want of agreement between his own results and those of Seeliger It appears that the taking up of an ionic charge from the air depends on the kind of water used and while Schmauss's result is obtained with distilled water Munich tap water behaves in the way described by Seeliger Experiments with NaCl solution show that this assumes a positive charge when it falls in drops through ionized air and in general Seeliger's results may be explained by the following experimental facts (1) Distilled water which exhibits a positive charge as Lenard effect takes up a negative charge in the drop experiments (2) NaCl solutions (and perhaps also Munich tap water) which shows a negative charge as Lenard effect takes a positive charge The opposite behavior of distilled water and NaCl solution shows that a charge action caused through Volta p d of the metallic parts of the apparatus is not the explanation of the effects but that there must rather be assumed specific forces acting between the liquid drops and the surrounding positive and negative ions The drops may draw to themselves those ions whose charge is opposite to their own on account of the charge arising from the Lenard double layer —*Annalen der Physik*

The Air-brake as Related to Progress in Locomotion—I*

The History of a Great Invention

By Walter V Turner, Chief Engineer, Westinghouse Air Brake Co, Pittsburg, Pa

GENERAL AND HISTORICAL

Every moving body is capable by virtue of its motion of doing an amount of work before its motion can be diminished or stopped which is directly proportional to the weight of the body and to the square of the speed at which it is moving In the case of a vehicle means must be provided which will permit this work to be done harmlessly and in a proper and predetermined manner Otherwise the element of danger involved increases so rapidly with the weight and speed of the vehicle that locomotion except in its most primitive stages is prohibitive The development of locomotion and consequently of transportation is therefore dependent in no small degree upon a like or even superior progress in the art of controlling vehicles in motion

The laws according to which this art progresses can be determined only by following the successive developments which have been made in train control apparatus This will be treated briefly in what follows dealing primarily with the principles upon which such apparatus must operate the methods both theoretical and practical by which these principles have been and are being applied to the problem in hand and the fundamental conditions of service which fix the requirements that must be satisfied by a reliable and practical device of this character

Primitive Vehicle Brakes Knowing that the ancients traveled extensively and that the great empires of history moved large armies over the then known world accompanied by trains of baggage wagons and war machines it is natural to suppose that the necessity for retarding those vehicles must have been plainly manifested But as a matter of fact the first suggestion of this necessity by the use of a practical mechanism designed for the purpose does not appear to have been more than 250 to 300 years ago The primitive carts and wagons which were used in agricultural work and in connection with the transportation of baggage and supplies for armies were of such construction that the natural resistance to rotation of their wheels was quite sufficient to bring them to a stop upon ordinary roads and in cases of steep grades it was always easy to chain a log or stone (Fig 1) to the back of the wagon so that by dragging it over the ground the speed of the vehicle was checked

Indeed to find the time when the question of braking first came into prominence it is necessary to go no further back than the period when highways became sufficiently well made and maintained as to admit of a heavy vehicle being drawn over them at comparatively high speed

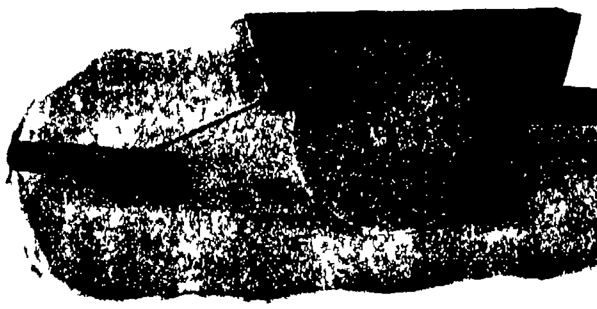


Fig 1—THE DRAG

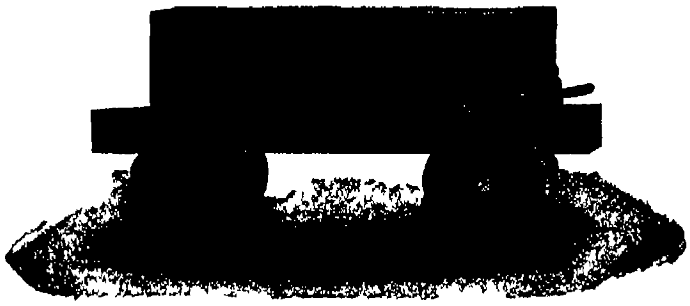


Fig 2—PRIMITIVE RAILWAY WAGON BRAKE

A remarkable adherence to one basic combination of elemental parts of the same general character and function is to be observed in even the earliest types of brake apparatus This extends from the simplest primitive forms through the entire progress of the art until they are found to-day associated it is true with great specialization and complexity of detail but still having essentially the same fundamental components

This is natural because as the moving vehicle must be controlled by self contained apparatus it was first necessary to devise means whereby a source of energy or pressure, located on the vehicle, might be made to generate retarding force, opposed to the motion of the vehicle

It is easy to see that the revolving wheels and axles offer the convenient and practicable opportunity required and consequently it is not surprising to find that practically all brake devices no matter how widely diversified in details have one feature in common This consists of a block or brake shoe as it is called so located that it may be pressed against the wheel tread with more or less force as may be necessary This develops a frictional force or pull between the relatively stationary shoe and the revolving wheel which so long as it does not exceed the adhesion of the wheel to the rail or roadway on which it rolls tends to retard and finally stop the motion of the wheel and thereby of the vehicle itself

Fig 4—STEVENSON'S STEAM LOCOMOTIVE BRAKE

It can be proved by experiment that the adhesion of a wheel to a rail while rolling (static or, more properly rolling friction) is greater than the frictional force at this point when the wheel is sliding (kinetic friction) Therefore the maximum retardation on the vehicle as a whole is obtained when the brake shoe pressure is such as to produce a frictional force at the shoe nearly but not quite sufficient to cause the wheel to slide This explains why wheel sliding must be avoided for theoretical as well as practical reasons

Early Railway Brakes—One of the earliest and simplest means of retarding the wheels of a vehicle in this way was forced by a change in existing conditions just as the many subsequent changes in methods of locomotion have been responsible for the perfection of the brake as we know it to-day About the year 1630 an enterprising mine owner at Newcastle-on-Tyne finding the roads between his mine and the river so bad as to seriously interfere with the hauling of coal, conceived the idea of laying wooden rails in the road and running his cars thereon The tractive effort of these cars was thereby so much increased that the necessity of some contrivance to check their speed was at once apparent and brought out simple forms of brakes One of these forms consisted of a metal tipped beam which was fastened to the frame of the car in such a way as to scrape along in the ground at the side of the track. Another form was a simple lever pivoted to the side, near the center of the car, and ordinarily held up by a chain, which, when desired for use, could be liber-

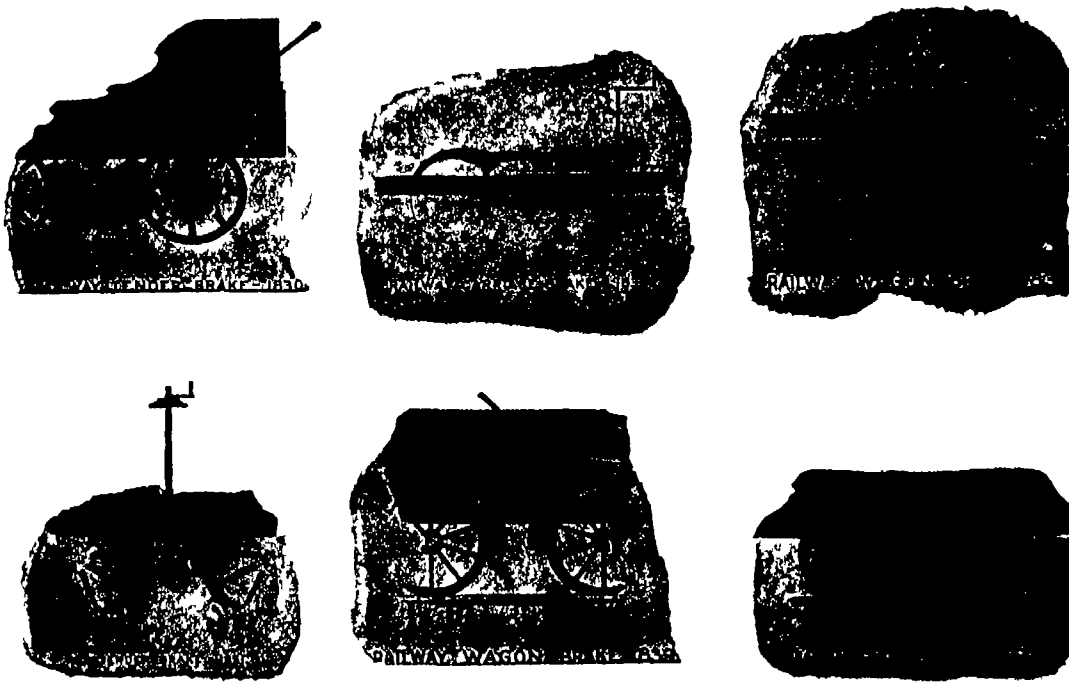


Fig 3 SIMPLE AND EARLY TYPES OF HAND BRAKES

* Presented at the meeting of the Mechanical and Engineering Section

ated and pressed by hand or foot against the top of the wheel as shown in Fig. 2

Many other simple devices of like nature were adopted by such rail or tram roads as then existed which require mention only to point out that all made use of a block or shoe forced against the tread of the wheel either directly or through the medium of some simple combination of rods and levers whereby the strength of the man applying the brake might be augmented or multiplied (Fig 3)

The Steam Brake—As the speeds on these roads were generally quite low and the cars small enough to be drawn by draught animals such devices served all practical purposes until the inauguration of a new order of things by the advent of the steam locomotive With the speeds and weights of cars which then had to be reckoned with it soon became evident that something better than a manually operated brake was needed In 1833 Stevenson patented his steam brake (Fig 4) in which steam pressure acting on a movable piston was made to take the place of the hand-operated mechanism by which the force was applied through a system of rods multiplying levers (and cams in this case) to the brake shoe In this first form of power brake we have all the elements of a complete power brake viz

1 Source of power—steam

2 Means whereby this power may be made to act

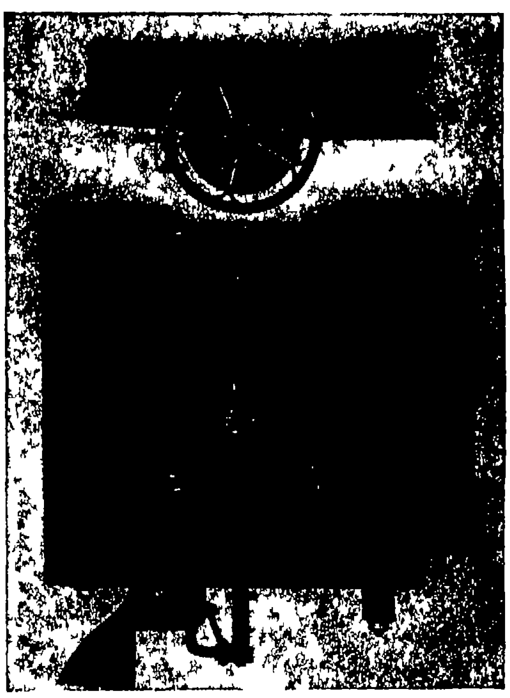


Fig 5—CREAMER BRAKE 1853

upon the rods and levers of the brake rigging proper—a brake cylinder with movable piston and rod

3 Connecting rods and multiplying levers to transmit and increase the pressure exerted on the brake piston—called the foundation brake gear

4 Means for transmitting the force exerted through the foundation brake gear to the wheels as retarding force or 'pull'—this being the function of the brake shoes as already explained

In the case of the cars the hand operated brake with various forms of foundation brake gear met all practical requirements for some time though a general realization of the necessity for some form of power brakes is attested by the fact that during the first seventy years of the nineteenth century about 650 patents were granted in England for various kinds of brakes for railroad service

PNEUMATIC BRAKE

The first pneumatic brake was a vacuum brake patented by James Nasmyth and Charles May in 1844 In 1848 Samuel C Lister patented an air brake having an axle driven pump and suitable reservoir to be placed on the Guard's Carriage and suitable cylinder pipe and connections on the various cars to constitute a straight air equipment much the same as that which followed many years after except that it was designed to be operated by the guard and not by the engineer

Continuous Train Brake—Of course the earlier types of hand brakes underwent considerable improvement, but while the majority of passenger as well as freight cars, were braked by hand as more and heavier cars came to be handled in the same train the necessity for a continuous brake or one capable of being put in action on the various cars comprising the train at the will of the engineer himself became more and more evident Some of the various systems originating in this country were extensively tried and seemed to meet the conditions for which they were designed with various degrees of success The Creamer brake (Fig 5) which was brought into use in 1853 consisted of a large spiral spring attached to the brake staff at the end of the car and which was wound up by the brakeman immediately after leaving a station Attached to the mechanism was a cord which ran through the train to the engineer's cab and the brake was so designed that when the engineer pulled the cord the coil springs on each vehicle were released and these at once wound up chains leading to the foundation brake gear thereby bringing the brake shoes against the wheels

The Loughridge Chain Brake (Fig 6) which came into use in 1855 consisted of a system of rods and chains continuously connected throughout the train as follows On each vehicle were two pairs of small pulleys each pair sliding toward the other upon an iron framework but held apart by a spring to each pair was connected a chain leading to the foundation brake gear Upon the engine was placed a drum connected by a worm and gear to a small friction wheel which in the engineer's cab was pulled this friction wheel was brought into contact with the periphery of one of the driving wheels thereby causing the drum to wind up the chain and shorten its length throughout the train in so doing the pulleys upon each vehicle were brought closer together thereby applying the brakes

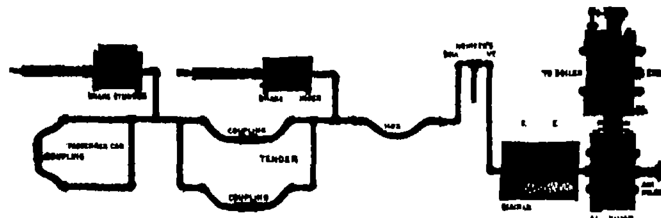


Fig 7—STRAIGHT AIR BRAKE

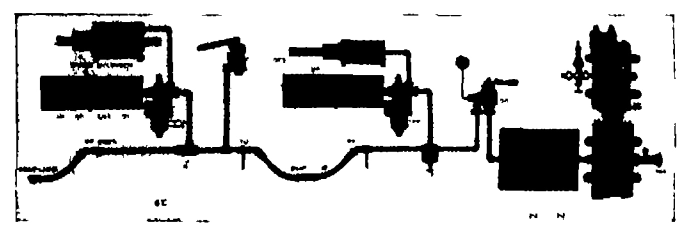


Fig 8—THE WESTINGHOUSE PLAIN AUTOMATIC AIR BRAKE 1872

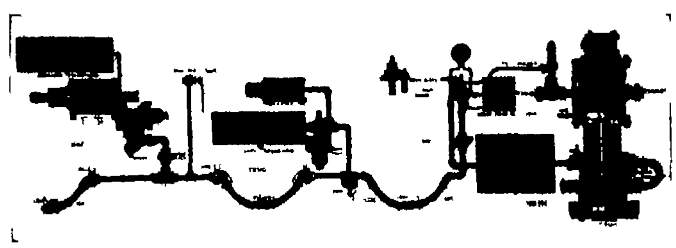


Fig 9—THE WESTINGHOUSE SYSTEM QUICK ACTION AUTOMATIC BRAKE 1887

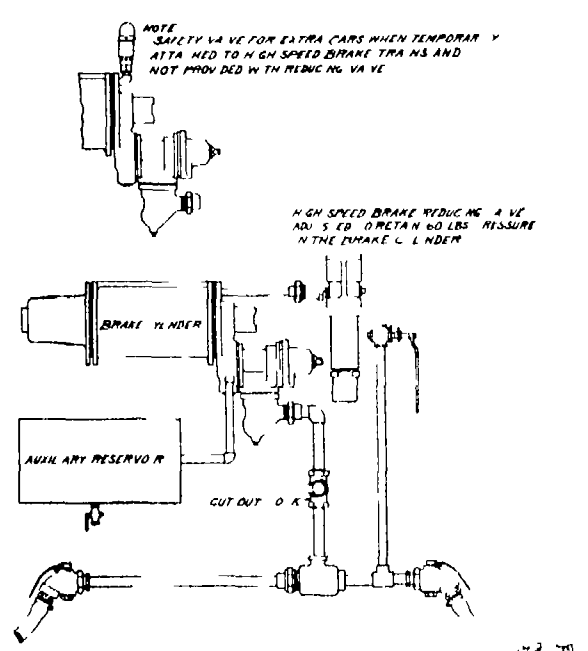


Fig 10—HIGH SPEED PASSENGER BRAKE

In addition to the above various forms of continuous brakes other than air brakes were tried to a greater or less extent from time to time Among those may be mentioned the Smith Vacuum Brake the Westinghouse Vacuum Brake the Eames Vacuum Brake the Hay Mechanical Brake the Clark & Webb Chain Brake the Barker Hydraulic Brake the American Buffer Brake the Widdifield & Button Friction Buffer Brake the Rote Buffer Brake the Carpenter Electric Air Brake and the Card Electric Brake From the length of this list it will be seen that to give an adequate description of these various systems would be to occupy with matter of purely historical or curious interest valuable space and the time of the reader which promises already to be overtaxed by the demands of modern practice and recent development

While these types of brakes were the result of much ingenuity and skill and attained to a degree of success sufficient to prove the necessity for and advantage of a reliable and efficient continuous brake

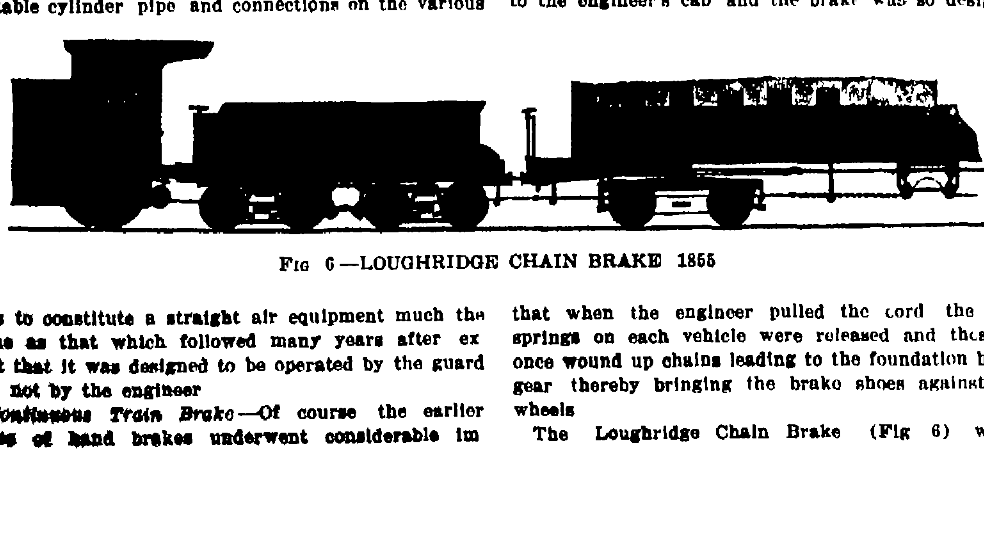


Fig 6—LOUGHRIDGE CHAIN BRAKE 1855

none of them satisfied enough of the fundamental requirements of a practicable continuous brake to result in their universal acceptance as a standard in this country

The Air Brake—Straight Air Type The first steps of the complete solution of the problem were taken and a new line of development opened up by the genius of Mr George Westinghouse who in 1869 took out his first patents for the Westinghouse Non Automatic Air Brake since generally designated as the Straight Air Brake

The source of power adopted for this system was the expansive force or pressure of compressed air obtained from a steam actuated air pump placed upon the side of the engine and a reservoir in which the compressed air could be stored A pipe line from the reservoir was carried throughout the length of the train connections between vehicles being made by means of flexible hose and couplings Each vehicle was provided with a cast iron cylinder the piston rod of which was connected to the brake rigging in such a way that when the air was admitted to the cylinder the piston was forced out and the brakes thereby applied A three way cock or valve located in the engineer's cab by means of which compressed air could be admitted to the train pipe and thus to the cylinders on each car to apply the brakes or the air already in the cylinders and train brake pipe could be discharged to the atmosphere thus releasing the brakes

An early form of the Straight Air Brake is shown in Fig 7 The air pump is one of the first forms to come into general use the so-called trigger or jigger valve motion and octagonal piston rod being features of particular interest

This type of apparatus has many good qualities and a very large degree of flexibility that is the increase or decrease of the pressure or braking power so called was under the control of the operator to a very marked degree but had shortcomings which made it unsuitable for use on trains of any considerable length on account of the time required to apply and release the brake and the unequal braking effort throughout the train More important still the factor of safety was low as no warning was given in the event of the hose coming uncoupled and a parted train meant no brakes Thus it is seen that it lacked the first essentials of an efficient brake which is that it must be its own telltale That is if an accident occurs to the system it must result in a brake application instead of a loss of the brake

PLAIN AUTOMATIC AIR BRAKE

In the natural process and development of railroads the requirements became more exacting and it was evident that the straight air brake was not only unsuitable for the reasons just mentioned but that it lacked essential features It became more than ever important that the brake must apply automatically in case of the train parting This was so fundamentally necessary that even if the flexibility of the straight air brake had not already been lost to a large extent by the lengthening of the trains it would have had to be abandoned because of the infinitely greater safety inherent in a brake of the automatic type Therefore the straight air brake having served its purpose as an advance agent of something better gave way to the automatic brake which afterwards came to be called the plain automatic brake to distinguish it from a later type that locally reduced the brake pipe pressure thus producing what is called quick action

The first form of this brake probably the greatest advance ever made in the art was invented and introduced by Mr George Westinghouse in 1872 (Fig 8)

The automatic feature resulted from the obtaining of an indirect application of the brakes through the medium of a valve device called a triple valve and an auxiliary storage reservoir which were added to the brake cylinder on each car All of the triple valves were connected together by a continuous pipe called the brake pipe with flexible connections between the cars this pipe being charged with air whenever the brakes were in operative condition By this means the auxiliary reservoir was charged with compressed air for braking purposes on the vehicle to which it was attached therefore it was no longer necessary to transmit the air *from* the locomotive to the vehicle when an application of the brakes was desired The triple valve is the essential mechanical element in such a system possessing the three functions of charging the auxiliary reservoir and of applying and releasing the brakes in accordance with variations in the air pressure carried in the brake pipe the medium for producing such operations as desired being for all general operations a manually operated brake valve on the locomotive

By means of this valve the engineer could apply the brakes *either* to a part of their capacity by steps or graduations or fully by a continuous decrease of the brake pipe pressure but he had no control of the release of the brakes (as with the straight air) The automatic brake releasing locally on each car while the release of the straight air brake was controlled on the engine Therefore one of the elements of flexibility possessed by the straight air brake was lost, but as has been said this feature had already been very much reduced in value by the lengthening of the train

Thus through the instrumentality of the triple valve the air brake became automatic which term applies to that *application* of the brakes which occurs through any material depletion from any cause of brake pipe pressure either at the will of the engineer by hose parting burst hose leakage or at the instance of the train crew so that this system very materially increased the factor of safety and permitted the use of air brake on longer passenger trains and on the already existing freight trains in a way that was not possible with the straight air brake equipment

Quick Action and Automatic Air Brake—This plain automatic brake was a great improvement in many respects over the straight air brake but chiefly from an emergency or safety standpoint for much of the flexibility (that is the ability of the operator to increase or decrease the cylinder pressure at will and for any desired number of times in rapid succession) for ordinary service brake operations had to be sacrificed This brake served the purpose fairly well while trains were short and speeds weight and frequency low but as these factors changed *its* limitations became more and more apparent particularly with reference to emergency operation The application was too slow with long trains *and for* reasons differing only in degree from those which had affected the straight air brake Thus when a quick application was attempted the shocks were great nor was the stop as short as required The reason for this slowness of operation was because the air in the brake pipe could not be quickly and uniformly reduced throughout its whole length this because of increased volume frictional resistance and the necessity of its traveling to the one outlet which was through the brake valve at one end of the train This limitation was overcome by the invention (in 1887) *of the* quick action triple valve and the equipment with which it was used came to be known therefore as the Quick Action Automatic Brake (Fig 9) The quick action triple valve was identical with the plain triple valve as far as service operations were concerned but differed from it in emergency in that it automatically vented air from the brake pipe locally on each car The rapid brake pipe reduction thus resulting is transmitted to the next triple valve and from it serially in the same manner to all the valves in the train thereby reducing the time of full application to about one sixth of what is inherent with plain triple valves on a fifty-car train and shocks were therefore correspondingly lessened and stops shortened The reason for this is that the brake pipe reduction with the plain triple valve took place at only one point in the train instead of fifty as with the quick action valve

The feature of serial venting of the brake pipe was so important that a second feature of this brake system which the first mentioned made possible was and is to-day overlooked by many and perhaps is often not rated at its true value This feature was the then possible attainment of a different and higher braking power for emergency than for service applications Up to this time the cylinder pressure or retarding force attainable had been the same for both service and emergency application but now since the brake pipe pressure vented could be and as a matter of fact was vented into the brake cylinder with one form of the device the pressure therein was materially increased whenever quick action took place

From this it will be seen that to the automatic and graduating features of the brake two others were added namely serial quick action and difference or increase in braking power between service and emergency applications All four of these are now generally recognized (though often not appreciated as they should be) as being fundamentally essential in a brake worthy the name Moreover these four features have had and still have great possibilities of extension and development Attention should be called again to the wonderful adaptability of the original combination of brake cylinder triple valve and auxiliary reservoir to the ever increasing need of more powerful and what naturally follows a more flexible brake It is truly remarkable that through all subsequent improvements not one of the original functions of the triple valve has been discarded but that they have been extended and expanded and many new functions added

So far the apparatus employed was the same for both passenger and freight cars but the still greater frequency of trains heavier vehicles and higher speeds made it necessary to provide means whereby a still greater stopping power for passenger service might be available when needed, particularly for emergency applications This was possible only by increasing the air pressure, since any other method would have made the brake too severe for low speeds In other words, the percentage of braking power per pound of cylinder pressure was already as great as practical operation would permit.

THE HIGH SPEED BRAKE.

It was thought, however that to increase the brake pipe pressure sufficiently to give the desired braking power would result in unpleasant or dangerous shocks slid and flattened wheels and other damage from the high brake cylinder pressure obtainable therefore this was not done until the valve known as the high speed reducing valve was perfected in 1894 The principles utilized by this type of apparatus had been thoroughly demonstrated by the classic Westinghouse Galton tests in England in 1878 These tests showed that, while the adhesion between the wheel and the rail—which causes the wheels to persist in their rotation—is practically uniform at different speeds the friction between the brake shoe and the wheel—which acts as a resistance to the rotation of the wheel and thereby stops the train—is considerably less when the wheels are revolving rapidly than when they revolve slowly It was thus demonstrated that a greater pressure not only could be safely applied to the wheels by the brake shoes at high speeds but also that such considerably greater brake shoe pressure *must* be applied to the wheels at high speeds in order to then resist the motion of the train as effectively as it is resisted with a more moderate brake shoe pressure at low speeds This was accomplished by the use of a higher brake pipe air pressure with the standard quick action apparatus with only the addition of a high speed reducing valve attached directly to the brake cyclinders This device was designed to limit the brake cylinder pressure obtainable during a service application of the brakes to what was considered safe and necessary but when an emergency application of the brakes was made to permit the brake cylinder pressure to rise to a considerably higher value than the maximum permitted in a service application and then to cause a gradual reduction of brake cylinder pressure quite slow at first but becoming more rapid so as to proportion as far as possible with such a device working on a fixed range the blowdown of brake cylinder pressure to the reduction in speed as the stopping point is approached Superior stopping capacity was obtained as already stated by increasing the brake pipe air pressure from the generally adopted 70 pounds as used with a quick action brake equipment to 110 pounds which in emergency applications and with the sizes to brake cylinder then in use would give about 85 pounds cylinder pressure in stead of about 60 pounds or in other words raise the nominal percentage of braking power from 90 to 125 per cent of the weight of the vehicle

With this improved equipment when an emergency application was made full cylinder pressure (85 pounds) was quickly obtained but was automatically reduced to 60 pounds and held at this point by means of the automatic reducing valve Thus if the stop was long enough the initial nominal percentage of braking power was 125 per cent while the final was 90 per cent but the actual retardation of the train kept fairly constant due to the difference in the retarding power of the shoes at high and low speeds already mentioned Though the co-efficient of brake shoe friction was known to be less at high speeds than at low speeds it was predicted by many that much wheel sliding would result from raising the nominal power above 100 per cent of the light weight of the car but on the contrary wheel sliding was lessened and naturally so when the situation is analyzed

In service applications the opening from the reducing valve was larger than in emergency application so that if such a reduction or brake pipe pressure was made as would cause the brake cylinder pressure to rise above 60 pounds the reducing valve would open and vent the air which otherwise would cause an undesirably high brake cylinder pressure to the atmosphere

This combination with the quick action triple valve is known as the high speed brake and is illustrated in Fig 10

(To be continued)

Grain Standardization and Wheat

THE study of grain standardization has been progressing satisfactorily Three hundred samples of various varieties classes and grades of wheat were experimented with in connection with the improvement of the handling and marketing of this crop The important study of seed testing for the purpose of improving the quality of the different seeds and for ascertaining the particular seeds for different climates is being rapidly developed The Department of Agriculture has been directing special effort to extend the area of possible cultivation of hard winter wheat by the introduction of varieties harder than those now grown. The Kharkov variety has proved to be the best.

Correspondence

The Bergen-Christiania Railway Contrasted with Two American Railroads

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT

The description of the grades of the Bergen-Christiania Railway given in the SCIENTIFIC AMERICAN of February 11th last gives a basis for a profile which I have constructed and present herewith For purpose of comparison I have prepared outline profiles of two American railroads on the same scale and covering nearly the same distance

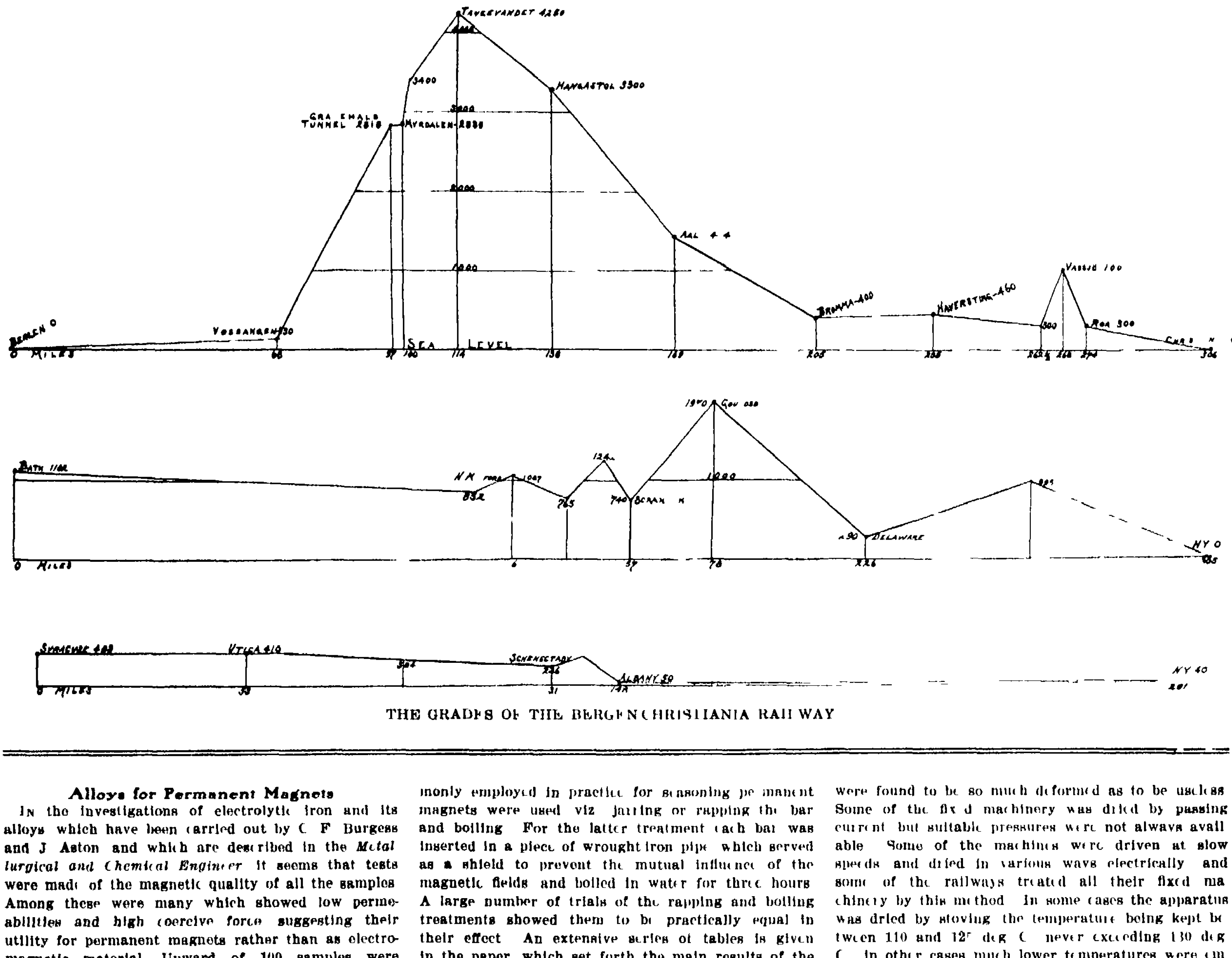
The Bergen-Christiania Railway was recently opened across the Scandinavian peninsula and the profile shows how it climbs the mountains in order to save forty out of fifty four hours of travel Owing to the necessary difference between the horizontal and vertical scales the grades are of course greatly exaggerated.

Fig 2 shows the Delaware Lackawanna and Western Railroad for nearly three fourths of its distance between New York and Buffalo At its highest point in crossing the Pocono Mountains in Pennsylvania it is nearer the clouds than any of the four other trunk lines between the two cities yet considerably less than half as high as the Scandinavian Railway The steady climb westward to Bath at 1 102 feet is continued beyond the bounds of this drawing till a second summit is reached at Wayland at 1 361 feet then it is a rapid descent into the Genesee Valley at Groveland 448 feet and another moderate climb to East Bethany 1 006 feet to surmount the watershed which all the other lines also must conquer in getting into Buffalo

Fig 3 is the profile of the New York Central Railroad for two of its three main divisions between New York and Buffalo The contrast between this grade and those of the Scandinavian and Lackawanna railroads is very marked It is rightly called the water level route There is no ascent all the way to Albany

From there a sharp ascent followed by a swift descent brings the trains into the Mohawk Valley which gives an easy grade to Utica and Rome from which the long level of the Erie Canal is duplicated by the long level of the railroad to Syracuse where the altitude is barely above 400 feet The highest station on the line is Batavia 895 feet The Scandinavian Railway ascends more than four times the greatest altitude reached by the New York Central and nearly ten times anything reached between New York and Syracuse—for there is a little summit of 477 feet west of Utica—and 80 times the highest point between New York and Albany

Rochester N Y FREDERIC CAMPBELL



THE GRADES OF THE BERGEN-CHRISTIANIA RAILWAY

Alloys for Permanent Magnets

IN the investigations of electrolytic iron and its alloys which have been carried out by C F Burgess and J Aston and which are described in the *Metallurgical and Chemical Engineer* it seems that tests were made of the magnetic quality of all the samples Among these were many which showed low permeabilities and high coercive force suggesting their utility for permanent magnets rather than as electromagnetic material Upward of 100 samples were tested for this feature all of the bars contained Cr Mn Mo Ni and W as binary alloys or in various combinations together or with other elements The tests recorded in the paper are for the most part on carbon free alloys The results are mainly of value therefore as indicating the influence of the various elements in inducing the conditions necessary for a good permanent magnet They were carried out on an Esterline permeameter The bars were tested as forged and after water quenching at 1 000 deg C To prevent oxidation of the samples while heating them for quenching a barium chloride bath was used The quenching at 1 000 deg C will probably not have brought out the best qualities of some of the bars but it was deemed the best general treatment since with so many bars under test it was impossible to subject each sample to tests for its critical points and special conditions of heating In addition to these general tests all bars which showed a fair retentivity and a coercive force above 30 were subjected to a test of their ability to hold residual magnetism after shock For this test the bar was subjected to the maximum magnetising force of 200 C G S units and the retentivity noted when this magnetising force was reduced to zero The bar was then removed from the machine, subjected to the disturbing factor and the retentivity again recorded after reinserting the specimen in the permeameter The two means commonly employed in practice for seasoning permanent magnets were used viz jarring or rapping the bar and boiling For the latter treatment each bar was inserted in a piece of wrought iron pipe which served as a shield to prevent the mutual influence of the magnetic fields and boiled in water for three hours A large number of trials of the rapping and boiling treatments showed them to be practically equal in their effect An extensive series of tables is given in the paper which set forth the main results of the investigations From the figures it is deduced that Cr Mn Mo and W are the most important elements for use in the manufacture of permanent magnets The presence of a third element is necessary While carbon is beneficial it is possible to obtain highly satisfactory materials either by various combinations of the four above-mentioned elements or by suitable additions of Si or V the latter in particular being very suitable When the material for the permanent magnet is to be hardened by quenching the presence of a considerable amount of carbon is desirable

Effect of Paris Flood on Electrical Machinery

THE effects of the Paris floods on electrical machinery are described by Guery in the Societe Int Elect. Bull It seems that a great deal of damage was done by the floods to machinery both on railways and in central stations but of these 16 000 different units have been rendered serviceable without any rewinding Everything was first carefully washed to remove mud etc sometimes a bath of dilute sulphuric acid was used in cases where injury had been caused by the overflow of acid from accumulators Some sort of drying process was then adopted after the windings had been sufficiently loosened to expose them to the air Some sorts of insulation such as fiber press-spahn and cardboard were found to be so much deformed as to be useless Some of the fixed machinery was dried by passing current but suitable pressures were not always available Some of the machines were driven at slow speeds and dried in various ways electrically and some of the railways treated all their fixed machinery by this method In some cases the apparatus was dried by stoving the temperature being kept between 110 and 120 deg C never exceeding 130 deg C In other cases much lower temperatures were employed requiring a much greater length of time In one case [illegible] that of the State railways stoving under a vacuum was tried this seems to have given no result at 65 degrees a satisfactory result at 75 degrees but probably a better result at 100 degrees Some motors were more or less burnt so far as their insulation was concerned by passing overheated air through them It seems to have been found that both heating in air at 106 degrees and in a vacuum at 65 degrees were ineffective There were many failures with transformers but in most other cases success was attained provided no time was lost in beginning work Underground conductors supported on glass or porcelain were of course hardly affected and this was also the case with supports of paraffined wood used as a third rail support though here were a few failures Some of the older types of rubber cables were found to be useless for high pressures though serviceable for 110 volts even after being submerged for twenty days Paper cables generally speaking were little injured even after their immersion for a month under heavy pressures of water some damage was done and the junction boxes were a weak spot Batteries were found to be very little injured The paper concludes with some notes as to precautions that may reasonably be taken in future together with a brief notice of the various incidents of the flood of last year

Breakwaters on the West Coast of Jutland

The Vornpör and Hanstholm Walls

By C Van Langendonck

Two breakwaters have recently been completed on the west coast of Jutland one at Vornpör and the other at Hanstholm The object of the construction is to produce for the fishermen additional safety during their work in beaching their boats in stormy weather and to prolong the fishing season by enabling the men to go to sea under circumstances which would otherwise make it impossible for them to do so Both breakwaters form approximately a right angle with the coast but that at Vornpör has a direction northwest to north while that at Hanstholm runs due north There will consequently always be shelter at one side of one of the piers

The breakwaters which constitute an interesting piece of engineering work are each 1 000 feet long and their construction has involved an expenditure of about $500 000 The basis for the contract was the plan worked out by the Danish Water Construction Department according to which both breakwaters were to consist of concrete blocks of up to twenty tons weight which were to be placed within a framework of iron on a foundation layer of shingle laid to level the irregularities in the lime stone underneath The grooves between the iron frame and the concrete blocks and between the concrete blocks themselves were afterwards to be filled with neat cement The size of the iron boxes was 16 feet in the direction of the length of the breakwaters while the breadth at the top varied from 20 to 22 feet the batter on the side was 1 6 An iron box filled with concrete blocks was estimated to weight from 300 to 7 0 tons The surface of the iron boxes was to be of the same height as the ordinary water level

A modified construction was however proposed by the contractors Messrs F V Blom og Saabye and O Lerche viz the adoption of reinforced concrete boxes instead of iron boxes which were to form the section of the pier and yet at the same time like the iron boxes form the outer casing for the filling which consisted of concrete blocks The reason for these alterations was a desire to employ larger concrete blocks and to avoid the use of the temporary iron framework This suggestion was accepted by the authorities and the contractors received the option of either entirely or partly building the piers in this manner These concrete boxes have the same length and breadth as the iron boxes and a weight of 80 to 90 tons being divided vertically into three pieces They are filled with solid concrete blocks of about the same weight The proportions of the mixture forming the concrete boxes are 1 2 4 and in the solid blocks 1 3 6

Each of the two breakwaters consists of sixty two sections of which the one farthest out stands in about 20 feet of water on a firm limestone bottom Supposing a section of one of the outer boxes then cement through a pipe for which provision was made in the corners of the block In order to prevent the cement from running out into the sea the bottom was covered with sackcloth nailed to a timber frame, which was molded in the lower side of the bottom box This sackcloth was fixed by divers as soon as the lowest box section was placed in position and crane passed lie at 11 feet above the datum line, and all the rails on shore where the blocks were made, are of course at the same level It was the original plan to build the bridge of wooden piles, but in the whole of the outer section heavy iron piles had to be adopted as it was found impossible to drive effectively to the limestone bottom

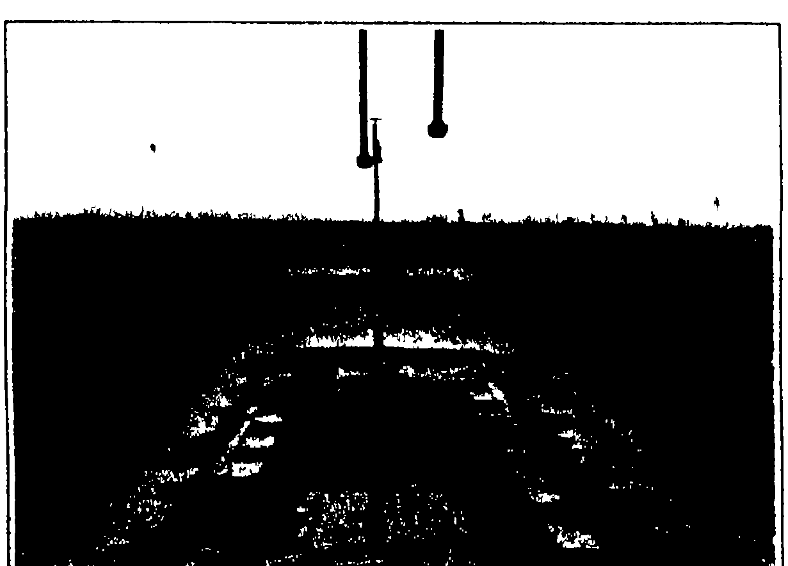
TESTING THE GREAT CRANE WITH A LOAD OF 12? TONS OF RAILS THIS CRANE IS USED FOR HAULING THE GREAT BLOCKS

weighed down by stone An upper monolithic portion of the pier was formed on the top of the boxes the topmost of which reached to from 1 foot to 2 feet above ordinary water level Into the upper portion was placed a number of old rails in the longitudinal direction of the pier Both the outer sides of the boxes and the upper structure are covered all over with granite facing bedded into the concrete Outside the breakwater on both sides and in front of it is placed a protecting apron in the shape of concrete blocks 3 feet to 5 feet high also covered with granite pavement This is quite necessary owing to the wear and tear from sand and pebbles through the incessant motion of the waves These protecting blocks have a weight of 8 to 15 tons each and lie in pairs in the outer portion there is a triple row A space as already mentioned was left between the shore and the nearest end of the breakwater so

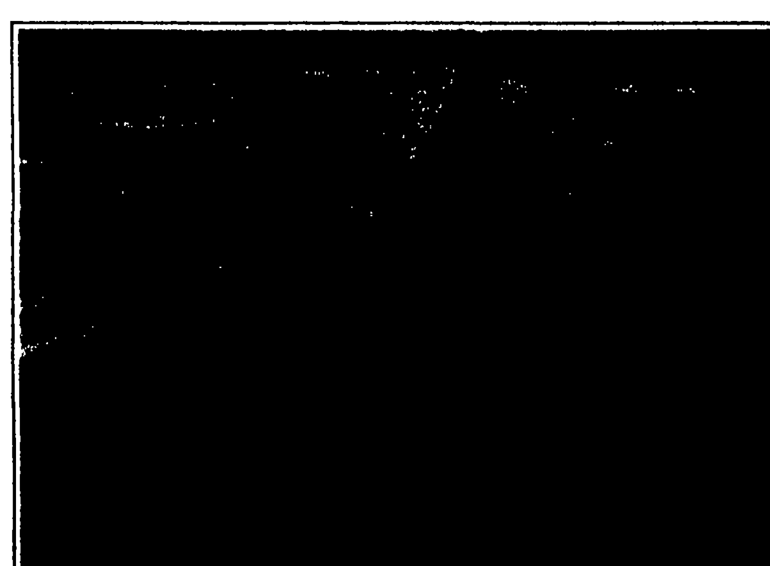
The upper structure of the breakwaters was built in the following manner Concrete blocks made on shore were placed on both sides in final position and the space between these was filled in on the spot with concrete

The arrangements on shore comprised three casting pits which formed a right angle with the direction of the pier The blocks were transported from the casting pits to the rails by means of a Goliath crane This last placed the block on a truck which then conveyed it to the crane at the end of the pier

The work at Vornpor was commenced in the summer of 1904 by constructing the molding pits for the concrete blocks and the building of the pile bridge to the breakwater when the placing of the boxes was commenced In the autumn of 1905 six boxes were laid in 1906 nineteen the following year fourteen in 1908 nineteen while the two remaining



THE OUTER PORTION OF THE BREAKWATER IN THE COURSE OF CONSTRUCTION



THE BREAKWATER NEARING COMPLETION

BREAKWATERS ON THE WEST COAST OF JUTLAND

the former would consist vertically of three boxes The interior space is filled with solid blocks and the large intervals between the blocks with small stones averaging about an inch in size similar stones forming the layer upon which the blocks rest As soon as the inside blocks were brought into position these intermediate spaces with the stones were filled with that a current could pass between the breakwater and the land This gap had of course to be bridged On account of the heavy traffic which had to pass over it, this connecting piece had to be constructed of substantial materials The transverse beams consist of eight timbers of dimensions varying from 14 by 14 inches to 16 by 16 inches The rails along which the ones were placed in the spring of 1909, when the work upon the upper structure was taken in hand, proceeding from the outer end in the direction of the shore The Vornpör breakwater was completed in the course of last year (1910) The work has proceeded in a satisfactory manner, and there have been no mishaps Stormy weather has proved a

hindrance now and again, and in order to be more independent of turbulent seas, concrete screens, so arranged that they could be used at different depths were made and occasionally used. They, in a way, answered their purpose, but their practical value was not very great, still they were serviceable in cases of emergency. The building of the Vornpör breakwater has had the unexpected effect that the sea north of the breakwater has made considerable inroads on the shore both on the foreshore and the

THE VORNPÖR BREAKWATER NEARLY COMPLETED

more elevated coast some houses having been washed down.

At Hanstholm the work was commenced in the spring of 1904. The original scheme with iron boxes was adhered to at this breakwater as far as the work hitherto done is concerned. The first box was placed in position in April 1905 and in the course of the same summer eight additional boxes were placed. The work was then discontinued pending the completion of the Vornpör breakwater. Now the heavy plant has been conveyed from there to Hanstholm and the work will be continued in accordance with the modified system used at Vornpör.

Our photographs represent the different phases of the building of the Vornpör breakwater.

Production Per Acre Overtaking Population Increase

Production per acre is beginning to overtake increase of people declares the Secretary of Agriculture in discussing one of the features of his report. The evidence is very plain that the yields per acre of our crops are now increasing and if the facts were assembled in detail for the States it would be found that the percentage of increase in yield of many of them is greater than the percentage of normal increase of population—that is the increase of births over deaths in the old native element.

That this is a fact, in greater or less degree is stated comprehensively in the report. During the ten years, 1896-1905, the production of wheat per acre on the average increased over the average of the preceding ten years in a greater degree than the normal increase of population (that is, apart from immigration and the temporarily high birth rate of the foreign born) in twenty-six States, and two more States are all but ready to join them. In fourteen States corn production per acre has increased faster than the normal increase of population and this is almost true of five more States. The number of States in this list in the case of barley is 21, rye 30, buckwheat, 19, cotton 3, potatoes, 24, hay 35, and more or less States are almost ready to enter this list in the case of all crops.

A demand that is more difficult to fulfill in production per acre is for an increase that equals or exceeds the actual increase of population including the immigrants and the temporarily high birth rate of the foreign born. But notwithstanding the fact that this difficulty is greater in the United States than it is in all other countries that have practically ceased to take much new land into cultivation many of the States of this nation are each maintaining an increase of production in the case of one or more prominent crops that is greater than the actual increase of population. Ten States are doing this in the case of corn for wheat the number is 22, for oats 16, for cotton and tobacco 1 each, for rye 21, for potatoes 15, and for hay 20.

We cannot look for any other result than that the yields per acre of all crops shall increase at an even faster rate in the future in view of the intense interest with which our people are turning their attention toward agricultural improvement. If there are certain forces at work which if unchecked and made more prevalent will in the future compel us to bid against the world for food, the counteracting forces have nevertheless been already set in motion with the promise of increasing effect.

Eradication of Animal Diseases

The work in cattle-tick eradication resulted in the release from quarantine of 57 518 square miles, the largest area released since the beginning of the work in 1906. The total area so far released is 129 611 square miles in 11 southern states.

Areas aggregating 390 000 square miles including all of Washington and parts of Oregon, Nevada, Utah, Arizona and Colorado were released from the sheep scab quarantine. A quarantine for this disease was placed on Kentucky. Areas released from quarantine for scabies of cattle amounted to 53,021 square miles. The Department inspected 52 749 920 sheep and 18 190 456 cattle while 12 153 356 sheep and 1 336 829 cattle were dipped under supervision.

In August 1909 a quarantine was established because of malignant lip-and-leg ulceration of sheep which appeared in Wyoming. The Department has kept a force of veterinarians in the field to assist sheepmen and state officers in treating the disease and to enforce the quarantine. About one-fourth the quarantined area has been released, the number of cases has been reduced and the spread of the disease prevented.

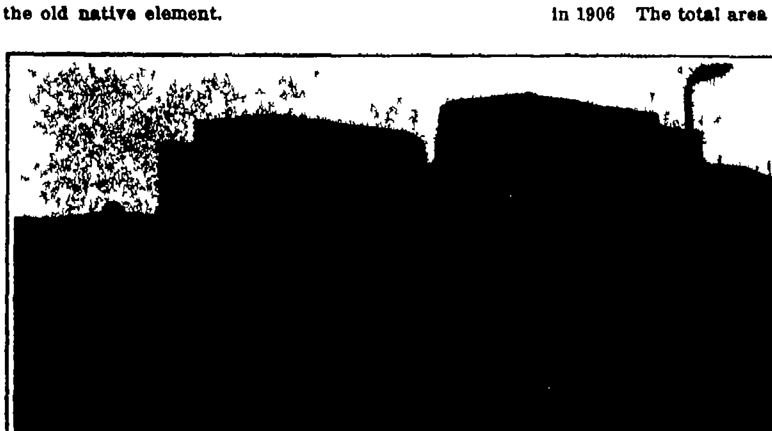
For the eradication of tuberculosis among cattle in the District of Columbia the Department arranged to test all cattle in the District with tuberculin, to supervise the slaughter of those that reacted to the test and to reimburse the owners. Over 18 per cent of the cattle in the District reacted to the test and of these 98½ per cent showed tuberculosis on post-mortem examination. All cattle brought into the District are now tested. It is also intended to retest the herds at intervals. Continued for a reasonable time this course will completely eradicate tuberculosis from the cattle of the District.

The efficiency of the serum treatment for the prevention of hog cholera devised by the Bureau of Animal Industry was strikingly demonstrated in a test at Kansas City. Thirty-five pigs were placed in a pen together, of which 4 had been inoculated with virulent hog-cholera blood, 22 injected with the preventive serum and 9 not treated. The 4 and the 9 died of hog cholera while the 22 remained well.

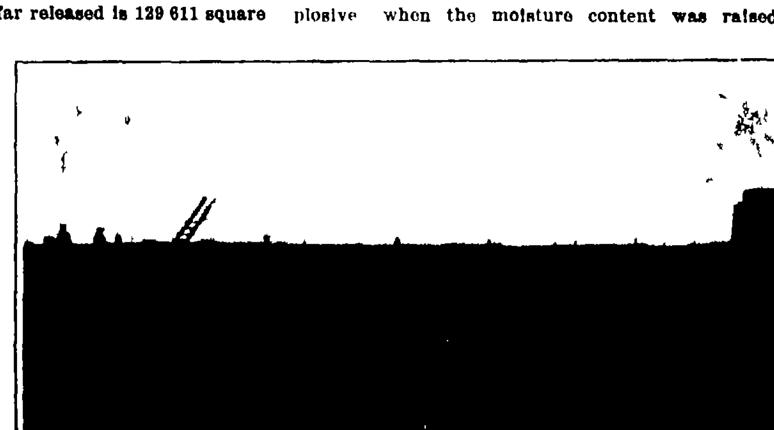
Coal-Dust Experiments at the Pittsburg Experimental Gallery

A preliminary account of the experiments which are being made by the United States Geological Survey is given by G. S. Rice in the bulletin of the United States Geological Survey Paper No. 425.

The gallery in which the tests are carried out was built in 1908. It consists of fifteen sections of riveted steel plates 6 1/3 feet in diameter, total length 100 feet; each section is 6 2/3 feet long and provided with a lateral window and a relief valve on the top. The gallery is closed at one end by a block of concrete 8 feet in depth, the gun used for igniting the dust is sunk flush into this block. Dust is spread on lateral shelves or blown into the gallery and kept in suspension by the ventilating current (Koerting exhauster and blower connected to every third section) but it does not appear that the stated dust densities per cubic foot of air space were really maintained. Ignition of the various dusts was obtained in all cases, propagation in most cases. Like Taffanel the experimenters believe that the inflammability of the dust is proportional to the percentage of volatile matter present. Experiments in which charges of 2½ pounds of black powder were tamped with dry or with wet coal dust were not decisive; the wet dust sometimes actually yielded longer flames (up to 64 feet long) than the dry dust. When moist preheated air was circulated through the gallery for many hours (up to 70) the explosibility of the dust was not decreased before moisture actually settled on the dust. Coal dust mixed and kneaded with water still remained explosive when the moisture content was raised to about 30 per cent (2 per cent being the natural moisture in the dust); the flame died away after 30 feet. The laboratory experiments on the absorption of oxygen by dust and on the explosive pressures were conducted by J. C. W. Frazer. The chief work in the gallery so far concerns the relative safety of different explosives.



TRUCK FOR CONVEYING THE BLOCKS FROM THE CASTING GROUND TO THE GREAT CRANE



VIEW OF THE CASTING GROUNDS SHOWING FOUR LARGE CONCRETE BOXES READY CAST AND LINED WITH GRANITE

BREAKWATERS ON THE WEST COAST OF JUTLAND

Potash Salts: Light on an International Controversy—II*

Their Uses and Occurrence in the United States

By W C Phalen

Concluded from Supplement No 1839, page 198

GERMAN POTASH SALTS IN THE UNITED STATES

According to Consul General A M Thackara of Berlin the American consumption of German potash in various forms embraces more than half of the export trade material and nearly 18 per cent of the entire production But while the great bulk of the potash salts consumed in the United States comes from Germany that country on the other hand is dependent on the United States for a large part of the mineral phosphates it uses

According to the latest report of the German potash syndicate the following are the quantities of several potash salts which were handled by its members and exported to the United States in 1908

Muriat of potash (chloride of potassium or Chlorkalium) at 80 per cent 288 524 metric tons[2] of which 10[illegible] 281 tons were consumed in Germany 104 048 tons were exported to the United States and the remainder to other countries The amount exported to the United States therefore was 36 per cent of the total

Fertilizer at 80 per cent (muriate of potash) 21 268 metric tons all of which was exported to Scandinavia and Denmark

Sulphate of potash (Schwefelsaurekali) at 70 per cent [illegible]4 751 metric tons of which Germany used 2 821 tons the United States 2[illegible] 000 tons (47 per cent) England 4 986 tons and France [illegible] 110 tons the remainder being sent to other foreign countries

Calcined sulphate of potassium and magnesium (double manure salts) at 48 per cent 3[illegible]7[illegible]6 metric tons of which 16 928 tons or [illegible]0 per cent were sold to the United States and 1[illegible] 124 tons to Holland the remainder being consumed in Germany and other countries

Crystallized sulphate of potassium at 40 per cent 16[illegible] metric tons all of which was used in Germany

Manure salts with 20 per cent 30 per cent and 40 per cent K O 284 989 metric tons of which Germany consumed 171 01[illegible] tons the United States [illegible]2 731 tons (18 per cent) Scandinavia and Denmark 24 005 tons and other countries the remainder

Calcined kieserite 668 metric tons of which [illegible]42 tons were used in Germany and the remainder in various other countries

Kieserite in blocks 2[illegible] [illegible]32 metric tons of which 20 [illegible]0 tons were consumed in Germany 2 794 tons (11 per cent) in the United States and 1 788 tons in all other countries

Kainite and sylvinite 2 388 381 tons of which Germany consumed 1 613 [illegible] tons the United States 3[illegible]1 322 tons (1[illegible] per cent) other countries 413 503 tons

Carnallite and Bergkieserite 74 38[illegible] metric tons of which 71 403 tons were used in Germany and the remainder exported

In the following tabulated statement compiled from official statistics are shown the production of potash salts in Germany during 1907 and 1908 the value of the products and the average value per ton

Production and value of potash salts in Germany 1907 and 1908

	1907		
	Quantity (Metric Tons)	Value	Average Value per Ton
Kainit	2 624 412	$8 505 840	$3 2[illegible]
Other potash salts	3 194 956	965 126	3 33
Muriate of potash[1]	[illegible]73,188	19 689 [illegible]04	36 73
Sulphate of potash	60 902	2,21[illegible] 982	36 [illegible]9
Sulphate of potash [illegible]	38,808	681 659	18 92

	1908		
	Quantity (Metric Tons)	Value	Average Value per Ton
Kainit	549 804	$8 812 496	$3 40
Other potash salts	3 [illegible] 035	8 064,690	2 30
Muriate of potash	508 692	13 307 [illegible]38	26 32
Sulphate of potash	55 55	2 03[illegible] 904	36 55
Sulphate of potash [illegible]	33 149	608 068	20 00

[1] Including 1[illegible] [illegible] tons of manure salts worth $1 849 780 in 1908 and 1 8[illegible] [illegible] tons of manure salts worth $1 193 332 in 1907

* Reprint of a bulletin issued by the U S Geological Survey

Daily Consular and Trade Report No [illegible]587

[2] A metric ton is equivalent to 2 204 pounds

FINANCIAL RESULTS OF GERMAN POTASH MINING

The following statement shows the results of the operations of 21 German potash mines in 1906

Operations of 21 German potash mines 1906

	Capital Stock or Paid up Assessment	Amortization and General Reserve	Net Profits	Dividends Paid	Per Cent of Capital
W[illegible]	$1 999 200	$[illegible] 599	$415,8[illegible]6	$[illegible]99 8[illegible]	15 0
A[illegible]	2 [illegible] 000	189 880	3[illegible] 805	2[illegible]5 [illegible]	10 [illegible]
Wilhelmshall	440 800	198 [illegible]	314 [illegible]38	285 600	64 8
[illegible]	476 100	112,059	192,067	285 600	60 0
Hedwigsburg	190 400	82 39	228,392	99 920	105 [illegible]
[illegible]	23 [illegible]	[illegible]	2[illegible]6 541	190 400	[illegible] 9
Salzdetfurth	1 666 100	142,819	377 856	2[illegible] 340	14 0
Hol[illegible]	1 [illegible]	108 458	200 [illegible]99	171 360	68 1
R[illegible]	1 499 900	109 114	150 [illegible]	142 800	9 9
[illegible]	1 142 400	86 215	181 921	154,[illegible]00	13 5
H[illegible]	1 149 4[illegible]	58 901	119 [illegible]00	119 000	10 1
J[illegible]	1 190 000	88 408	16 639	4 600	4 0
Kaiseroda	[illegible]00 200	84 951	14 560	142 800	[illegible]
B[illegible]	1 [illegible]11 50[illegible]	48 [illegible]	142 800	142 80[illegible]	14 1
T[illegible]	1 19[illegible] [illegible]	11 [illegible]66	118 096	95 [illegible]	8 0
W[illegible]	1 [illegible]	110 411	14 941	1[illegible] 941	18 5
Sig[illegible]	4 8 [illegible]	24 487	23 555	21 18	5 0
E[illegible]	1 568,866	88 499	118 118		
A[illegible]	1 280	182 248	216 831	142 80[illegible]	18 7
[illegible]	52 [illegible]	[illegible]9 462	84 11[illegible]	66 644	[illegible] 0
[illegible]	1 4[illegible] [illegible]	8 381	71 581		
Total	$2[illegible] 502 625	$2 2[illegible] 150	$8 4 [illegible] 0	$3 1 5 599	

The above statement shows that the 21 mines earned in 190[illegible] an average profit of 1 9 per cent on the invested capital and declared an average dividend of 13[illegible] per cent It can be safely assumed that the works not included in this statement also reached this average as among them were a number of the most profitable mines and but few of the minor companies

In discussing the position of the potash industry as developed by the late potash syndicate Thackara's report already cited gives some interesting information as to the cost of production of the different grades of potash salts based on expert opinion it being impracticable for several reasons to give the official figures The following statement shows the cost of production and the foreign and domestic prices of the several grades per metric ton

Cost of production and prices of potash salts

	Per Cent K	Cost of Production per Metric Ton	Price per Metric Ton: Foreign	Price per Metric Ton: Domestic
Kainit	12 4	$1 [illegible]4 to $1 9[illegible] 4	$1 [illegible] to $1	$3 [illegible]
Muriate of potash	[illegible]	11 [illegible] to 1[illegible] 85	33 [illegible]	3[illegible] [illegible]
Sulphate of potash	[illegible]	18 08 to 2[illegible] 18	3[illegible] [illegible]	39 [illegible]
Manure salt	[illegible]	8 [illegible] to 11 9[illegible]	13 [illegible]	15 [illegible]

Except for the 40 per cent manure salts the costs of producing which are higher in consequence of the small output the costs of production of the salts listed above vary between 40 and 60 per cent of the receipts from sales These figures are based on the normal running time of the works in 190[illegible] In the two years 1907 and 1908 the costs of production somewhat increased They may at some plants even have passed the maximum of 60 per cent The costs are still low however when compared to those of other mining industries In coal mining for example the costs of production amount to 70 or 80 per cent of the total receipts and are often even greater These facts explain how the selling policy of the potash syndicate and the comparatively low costs of production have stimulated the establishment of new plants

OCCURRENCE OF POTASH SALTS IN THE UNITED STATES

Igneous Rocks

Potash is abundant as a constituent of the rocks which form the crust of the earth According to F W Clarke the percentage of potash (K O) in the earth's crust is 3 00 this result being an average of 1 434 determinations made in the laboratories of the United States Geological Survey up to January 1st 1908 In some varieties of igneous rocks particularly those rich in the potash feldspars there is a large amount of potentially valuable potash The feldspars are widely distributed minerals and comprise about 60 per cent of the earth's crust Among the igneous rocks containing large amounts of potash are the glasses of which the chief are obsidian pumice perlite and pitchstone In these rocks the potash may run as high as 5 or 6 per cent The rhyolites are also rich in potash Examples of this rock containing more than 5 per cent of potash are common and a certain rhyolite from Silver Cliff Colo has been shown to contain 8 38 per cent[2]

[1] Bull U S Geol Survey No 419 1901 p 27

[2] Cross Whitman Proc Colorado Sci Soc December 5th, 1887 p 229

The trachytes and phonolites are also rich in potash consisting chiefly of that variety of potash feldspar (orthoclase) known as sanidine Some of these rocks are known to contain nearly 8 per cent of potash Among the granitoid rocks should be mentioned granite monzonite and syenite which contain considerable amounts of the potash feldspars The leucite rocks of the Leucite Hills, Wyoming contain so far as known the largest amount of potash among the igneous rocks These rocks have been described by Whitman Cross of the United States Geological Survey Certain of them wyomingite and orendite contain from 9 81 to 11 91 per cent of potash (K_2O) In many localities there occur large dikes or deposits of more or less pure feldspar commonly orthoclase which run much higher in potash than the ordinary granite rocks and may approach the theoretical potash content of pure orthoclase feldspar—16 8 per cent of potash Such deposits have been developed in the New England States Pennsylvania New York and Maryland where they have been mined extensively and the feldspar ground to fine powder principally for use in pottery manufacture These deposits may constitute in themselves a comparatively high grade fertilizer were the potash all available for plant food As the feldspar for use in pottery making must be almost entirely free from mica or iron bearing minerals large quantities of such potash rich material are rejected at every quarry But the potash of these rocks even when thus finely ground has been generally supposed to be tightly locked up being practically insoluble by any known cheap commercial process Ten eight or even five per cent potash rock of which there are millions of tons well distributed over the globe would be highly valuable as a fertilizer were there any known cheap method of making the potash available for immediate use to the growing plant

Experiments have been made by the United States Department of Agriculture[2] for the utilization of this potash supply through fine grinding or pulverizing the feldspathic rocks in a manner similar to the grinding for pottery So far as known these experiments have not been completed and the results thus far attained have not proved conclusive This source of potash has also been investigated by individuals among whom may be mentioned Dr A S Cushman formerly assistant director of the Office of Public Roads who on April 30th 1907 took out patent No 851 822 for a process for the extraction of potash soda and other soluble bases from ground rocks This patent is described as follows[3]

Feldspathic or other potash bearing rock is ground to fine powder slimed with water and placed inside of a suitable wooden container which is then set inside of another larger vessel Water is now placed in the outer vessel and electrodes inserted so that the inner or slime chamber becomes connected with the positive pole and the outer chamber with the negative pole A current of electricity from a dynamo is then turned on When this is done the potash soda, and other soluble bases are partially set free from the combinations with alumina and silica in which they exist in the feldspathic rocks

Under the influence of electrolysis the soluble bases pass through the wooden partition and the water in the outer vessel becomes alkaline owing to the accumulation of potassium and sodium hydroxide The electrical resistance of the cells arranged in this way is so high that only a small fraction of an ampere passes through under a potential of 110 volts After a certain percentage of the alkali has been extracted in this manner the action slows down and it has been found necessary to devise methods to accelerate it

Dr Cushman has discovered two methods of accelerating the decomposition of the rock slime and hastening the extraction of the potash (*a*) By a suitable grinding or churning arrangement the slime in the inner chamber can be kept in a continual agitation which causes the necessary reactions to go on more rapidly (*b*) If a small quantity of hydrofluoric acid is added to the slime a very great acceleration in the rate of decomposition and extraction is obtained and it is possible in a reasonably short time

[1] Am Jour Sci 4th ser vol 4, 1897 p 130

[2] U S Dept Agr Bur Plant Industry Bull. 104 1907

[3] Chem Engineer vol 5 1907 p 21, Bur Census, Bull. 92 1908 p. 39

to make a complete extraction of all the potash con tained

If instead of caustic potash it is desired to make various salts of potash such as are in ordinary use for fertilizers and other purposes—that is nitrate sul phate chloride and phosphate—the corresponding acids (nitric sulphuric hydrochloric and phosphoric) are fed in a dilute form into the outer or so-called cathode chamber fast enough to neutralize the caustic alkali as it forms By varying the amount of acid added the resistance of the cell can be controlled and the decomposition of the rock carried on under the best and most economic conditions

Greensand Marls of New Jersey

Potash is found in river waters but in smaller quan tities than soda (Na_2O) The difference is still greater in ocean water owing to the fact that the potash for some unknown reason is largely taken up by the sedi ments forming glauconite while the soda is largely held back in solution This glauconite is an important constituent of the greensand marls of New Jersey

About 30 years ago the greensand marls of the south ern portion of New Jersey were in great demand On the first geologic map of that State the location of the marl beds was shown and in some of the earlier re ports the deposits were described and numerous analyses given as well as instructions in the use of the marl In recent years however marl has been supplanted to a large extent by the more highly concentrated artificial fertilizers and is no longer dug extensively

The following analyses show the composition of the different grades of marl as dug and applied to the soil The glauconite or greensand in them is of nearly uniform composition but mixed with it are carbonate sulphate and phosphate of lime quartz sand sulphide and phosphate of iron shells etc The differences in the kind and quantity of these substances cause wide differences in the appearance of the marl containing them as well as in its com position and properties

The following table gives the potash and phosphoric acid content in percentages of typical specimens of New Jersey marl

Potash and phosphoric acid in typical greensand marl of New Jersey

	1	2	3	4	5
Phosphoric acid	1 14	1 33	1 16	2 34	2 69
Potash	5 05	6	6 22	5 18	6 31

	6	7	8	9	10
Phosphoric acid	2 56	3 58	3 8	3 58	30
Potash	4 62	3 5	4 11	4 2	8 53

New Jersey marl[1] has been of incalculable value to the region in which it is found It has raised this region from the lowest stage of agricultural exhaus tion to a high state of improvement Found in places where no capital and but little labor were needed to get it the poorest people have been able to avail themselves of its benefits Lands which in the old style of cultivation had to lie fallow by the use of marl produce heavy crops of clover and grow rich while resting Land which had been worn out and left in common are now by the use of this fertilizer yielding large crops of the finest quality Every where in the marl district may be seen farms which in former years would not support a family but which are now making their owners rich through their productiveness Bare sands by the application of marl are made to grow clover and then crops of corn potatoes and wheat Pine barrens by the use of marl are made into fruitful land The price of land in the greensand marl belt of New Jersey was considerably below that in the northern part of the State 40 years ago now that the lands are improved their price is higher than that of lands in the north ern part of the State

A recent invention[2] proposes to use glauconite or greensand (such as is found in New Jersey) as a principal ingredient in the manufacture of hydraulic cement In making the cement the potash of the greensand would be volatilized at the temperatures employed and its recovery as a by product would be possible

Salines

The known occurrences of potash salts in the United States are few in number Those which are known and which promise results are confined to certain arid portions of the Western States Here the structural conditions are favorable for the reten tion of any salines that may have been deposited and the presence of alkaline lakes suggests the possibility that others may once have existed and are now cov ered by later deposits, their saline content being concealed. Though potash salts occur in this region

[1] From Ann Rept. State Geologist of New Jersey 1886

[2] Patent 912988, dated February 9th, 1909

in the waters of the alkaline lakes it has yet to be proved that these waters contain a commercially valu able quantity of potash salts An idea of the quan tity of potash salts in the waters of some of these lakes may be obtained from the figures given in the following tables[1] Though the waters of these lakes have never been utilized for their content in potash it appears as if they would prove of some commer cial value It must be admitted however that the German deposits are unique not so much in the quality of the salts contained in them as in the quan tity and in the fact that the overlying geologic forma tions are such that they have been kept intact so far as known a condition which is as important as the deposition of the original material itself

Potash salts occur in the water of Owens Lake Inyo County Cal This lake at the present time has no outlet and on the completion of the Los Angeles aqueduct will be deprived of the greater part of the drainage hitherto tributary to it Its ancient shore line nearly 200 feet above its present level indicates that at one time it had an outlet to the south and was there joined to a chain of lakes Its waters are strongly alkaline and the principal salts contained in them are the chloride and carbonate of sodium A number of analyses more or less complete have been made of its water These vary according to the con ditions under which the samples were collected and the analyses made The dilution of the water of this lake after storms in the surrounding mountains and its concentration at the end of summer explain in part differences in the analyses One of the first anal yses of water from this lake is as follows

Analyses of water of Owens Lake

	Grains per imperial gallon
Sodium chlorid	14_ 1o
Sodium sulphat	9 6 80
Sodium carbonat	_914 4
Potassium sulphat	37 74
Potassium silicate	139 74
Organic matter	16 9

The following analyses are comparatively recent

Analyses of water of Owens Lake

[Grammes per liter]

	I	II
Silica	0 220	0 1 1
Iron and aluminium oxides	0 008	
Calcium and magnesium carbonates	0 055	
Sodium tetraborate ($Na_2B_4O_7$)	0 4	
Potassium chloride	3 15	
Sodium chloride	29 41	23 2830
Sodium sulphate	11 080	9 997
Sodium carbonate	26 968	21 4080
Sodium bicarbonate	5 15	
Potassium sulphate		6 148
Total	078	63 6025

F M Chatard analyst Bull U S Geol Survey No 60 1890 p 58

Oscar Loew analyst Ann Rept Geog Surveys W 100th Mer 1876 p 190

Analysis No I gives the following composition of the dried salts

Analysis of dried salts from Owens Lake

	Per cent
Silica	0 28
Iron alumina lime magnesia	0 13
Sodium biborate (borax)	0 03
Potassium chlorid	4 07
Sodium chloride (salt)	38 16
Sodium sulphate	14 38
Sodium carbonate	4 05
Sodium bicarbonat	7 40
	100 00

The waters of this lake also contain a small quan tity of lithia phosphates and nitrates The specific gravity of the water is 1 051

Analyses of the crude soda formed by solar evap oration of the water of this lake gave Chatard the following results

Analyses of soda from evaporation of water of Owens Lake[1]

	1	2	3	4	5	6
Water	20 8	14 61	4 38	3 48	3 1	11 03
Insoluble	1 55	0 078				
Organic matter silica alumina and lime and magnesium car bonates	0 5	0 29	0 09	0 06	0 06	0 18
Potassium chloride	0 51	1 07	1 12	1 14	1 21	2 93
Sodium chloride	3 51	7 44	35 06	45 59	60 99	19 6
Sodium sulphate	1 89	3 18	25 44	26 70	19 01	5 0
Sodium carbonate	40 87	43 5	22 84	18 19	12 11	55 04
Sodium bicarbonate	30 65	30 12	10 58	4 06	3 88	4 09
Sodium biborate						2 01
Totals	100 22	100 986	99 41	99 1	99 90	100 14

[1] Bull U S Geol Survey No 60 1890 p 61

From these analyses and from data similar to those given beyond in connection with Mono Lake it is estimated that Owens Lake contains among other con stituents 3 000 000 tons of potassium sulphate to-

[1] Bailey Gilbert Bull California State Min Bur No 24 1902 pp 94 et seq Chatard, T M Bull U S Geol. Survey No 60 1890 pp 27 101

gether with large quantities of sodium carbonate common salt, and borax These materials are, how ever, present in such dilute solution that they have not been utilized up to the present time The diver sion of Owens River however must gradually result in a notable increase in the alkalinity of Owens Lake and the conditions for the utilization of the potash salts will become more favorable

At Owens Lake the manufacture of sodium car bonate has been carried out on a commercial scale In order to determine the most favorable conditions for the process Chatard subjected a quantity of the water to fractional crystallization and analyzed the salts which were successively deposited Two con cordant series of experiments were made together with a less complete but corroborative set with water from Mono Lake The results of the first group were as follows

Analyses of salts deposited by fractional crystalliza tion of water of Owens Lake[1]

A The natural water of Owens Lake Specifi gravity 1 062 at 2 degrees Salinity 77 098 grammes per liter

B First crop of crystals Water concentrated to one-fifth its original volume Specific gravity of mother liquor 1 312 at 27 9 degrees

C Second crop of crystals Specific gravity of mother liquor 1 312 at 25 degrees

D Third crop of crystals Specific gravity of mother liquor 1 315 at 26 25 degrees

E Fourth crop of crystals Specific gravity of mother liquor 1 327 at 35 75 degrees

F Fifth crop of crystals Specific gravity of mother liquor 1 300 at 13 9 degrees This crop was obtained by chilling the solution in order to de termine the effect of cold

	A[2]	B	C	D	E	F
H_2O		11 51	4 93	9 43	8 31	11 03
Na_2CO_3	31 1	43	25 81	18 19	12 51	55 04
$NaHCO_3$	10	40 1	10 53	1 06	9 88	4 09
Na_2SO_4	14 98	3 18	27 44	26 0	11 01	5 0
NaCl	38 16	44	35 06	45 50	60 99	19 16
$Na_2B_4O_7$	0 63					
$NaBO_2$						2 01
KCl	1 05	1 0	1 15	1 14	1 21	2 93
(CaMg)CO_3	0 88	0 14	0 09	0 06		
$(AlFe)_2O_3$	0 05	1 01			0 01	0 07
SiO_2	0 28	0 062			0 05	0 16
Organic matt		0 032				
Insoluble		0 078				
Totals	100 00	100 586	99 41	99 1	99 90	100 14

[1] Clark F W Bull U S Geol Survey No 330 1908 p 192

[2] Composition of the anhydrous residue

[3] Chatard supposes that the biborate could not exist in so strongly alkaline a solution as that in their liquor from which this crop was obtained

Mono Lake is situated in Mono County Cal near the Nevada line at an elevation of 6 730 feet the highest level above the ocean of all the saline lakes of the Great Basin Its water is dense and alkaline At this lake the alkaline carbonates are abundant owing to the volcanic rocks of the lake basin as shown by the complete analysis made by T M Chatard as follows

Analysis of water of Mono Lake

	Grammes per liter
Silica	0 0700
Calcium carbonat	0 0810
Magnesium bicarbonat	0 3340
Potassium chloride	1 8342
Sodium chlorid	18 068
Sodium sulphat	9 8690
Sodium carbonat	18 6720
Sodium bicarbonat	4 9015
Sodium biborat	0 2000
Alumina	0 0030
	5 1 4

The results of this analysis show that chloride of sodium and carbonate of sodium constitute nearly 35 per cent each of the total solids Experiments by Chatard on the fractional crystallization of the min eral content of the water gave the results presented below which show the same general rule of depo sition as at Owens Lake The water used in the ex periments had already been evaporated to about one-sixth of its original volume and had a specific gravity of 1 210 The analyses are as follows

Analyses of salts deposited by fractional crystalliza tion of water of Mono Lake

	1	2	3	4	5
Water	15 28	10 98	0 69	4 18	11 31
Silica	0 05	0 1	0 16		0 13
Calcium carbonat	0 05	0 14	0 05	0 05	0 02
Magnesium carbonate	0 48	0 40	0 02		
Potassium chloride	0 09	0 09	0 4	0 1	15 20
Sodium chloride	19 18	21 34	29 96	60 5	35 93
Sodium sulphat	2 78	14 18	19 13	16 29	6 65
Sodium carbonat	36 87	41 07	18 25	14 23	33 00
Sodium bicarbonat	25 35	10 90	10 03	3 88	0 43
Totals	99 3	100 03	99 8	100 03	99 85

The lake has an area of 85 5 square miles and an average depth of 61 5 feet From these figures its

volume has been calculated From its volume and the mineral content of its water the amount of the various salines which it contains has been estimated The results which are of interest indicate the presence in the lake of 10 538 100 tons of potassium chloride Such figures show that the saline reserves in this and other incompletely evaporated or playa lakes of the desert regions of California and other public land States are very large and may prove valuable when transportation facilities have been developed and methods for the extraction of the salts perfected Potassium nitrate has been found in the desert region northeast of Salton Riverside County Cal

Alunite

Near the close of the year 1910 Mr A F Custer of Salt Lake City Utah sent to the United States Geological Survey a specimen of alunite (hydrous sulphate of potash and aluminium $K_2SO_4 3Al_2(SO_4)_3$, $6H_2O$) of a very unusual type The occurrence is reported to be located near Richfield Sevier County Utah close to the railroad The deposit varies from 6 to 10 feet in thickness

An occurrence of scientific and economic interest is the association of alunite and gold in the Gold field district of Nevada F L Ransome of the United States Geological Survey believes that the composition of the ores and the changes exhibited in the country rock point to hot ascending solutions as the agent which has produced the alunite On some of the ore dumps the partly soluble sulphate is present in sufficient quantity to suggest its removal by leaching Before undertaking such a step several factors must be considered such as quantity of raw material proximity to market transportation facilities and freight rates

POSSIBLE OCCURRENCE OF POTASH SALTS IN THE UNITED STATES

To make a thorough and complete investigation of the occurrence of potash salts in the United States every known salt deposit should be tested for ordinary rock salt may overlie soluble potash salts as well as underlie them Both these conditions exist at Stassfurt The normal occurrence of salt is however at the base of a series of soluble salines deposited from the evaporation of sea water The deposits of Midland and Isabella counties Mich are of interest in this connection inasmuch as they contain bromine in commercial quantity a fact which indicates partial desiccation of sea water and the occurrence of mother liquors The salt deposits of Mason County W Va and adjacent parts of Ohio likewise contain and are worked for bromine

[1] Econ Geology vol 2 No 7 1907 p 680 Ref Paper U S Geol Survey No 66 1909

The red beds of the southwestern part of the United States in Texas Oklahoma, Kansas, Colorado, New Mexico and possibly other States, contain deposits of gypsum and salt and are worth notice as possible sources of potash salts These beds might profitably be explored in those places where structural conditions seem to favor the accumulation and retention of the salines

ORGANIC SOURCES OF POTASH SALT [1]

The organic sources of potash salts are wood ashes beet-sugar molasses and residues wool scourings (suint) and sea weed

Wood Ashes

Land plants take up considerable quantities of potassium compounds from the soil When the plants are burned about 10 per cent of the weight of the ash is potassium carbonate which may be obtained by lixiviation Potash from wood ashes is now made chiefly in Russia Sweden and America the woods most employed being elm maple and birch Sometimes the stumps and small branches only are burned the trunks being used for timber The ashes are moistened slightly put into tanks having false bottoms on which straw is spread and then lixiviated with warm water The lye so obtained is evaporated (sometimes by the waste heat from the burning wood) in iron pots until it solidifies on cooling The dirty brown mass is then calcined in a reverberatory furnace until all the organic matter is destroyed The product is known as potash or crude pearlash It is white or gray in color and contains about 70 per cent of K_2CO_3, with some potassium sulphate potassium chloride and sodium salts By redissolving the crude potash in water and settling and concentrating the solution until the sulphate and chlorides separate as crystals a concentrated and fairly pure lye is obtained When this is evaporated to dryness and the residue calcined it yields a much purer product known as refined pearlash containing from 95 to 97 per cent of K_2CO_3 It is necessary that low heat be employed in the calcination for the charge fuses at a moderate temperature

Quicklime is often put in the bottom of the tanks before the ashes are introduced On leaching the solution of potassium salts reacts with the lime forming insoluble calcium salts and yielding more or less potassium hydroxide in the lye The resulting product is a mixture of potash and caustic potash

Beet sugar Molasses and Residues

In the manufacture of beet sugar a very impure molasses remains containing among other things a large amount of soluble potassium salts. This molasses is now generally fermented, and in that process the sugary substances are converted into alcohol, which is distilled off, leaving the mineral salts in the liquid residue, called "vinasse" or "schlempe." If this is evaporated to dryness and the mass calcined, the organic potassium salts are decomposed, leaving in the cinder about 35 per cent of potassium carbonate and a large amount of chloride and sulphate together with sodium salts

[1] Taken in part from Thorp F H Outlines of Industrial Chemistry 1901 pp 130 et seq

Wool Scourings (Suint)

Wool scourings furnish some potash in countries where much wool is washed. Sheep s wool as it comes from the animal contains from 30 to 75 per cent of its weight in impurities consisting of dirt, sand dung etc wool grease or "yolk a fatlike substance, made up of cholesterine and compounds in which it is associated with oleic stearic and palmitic acids and suint,' which consists chiefly of potassium salts of oleic stearic and other organic acids, with small quantities of chlorides and sulphate and nitrogenous matter The suint exudes from the animal in the perspiration and is deposited on the wool by evaporation It is soluble in cold water and is thus removed in the scouring process If the wash waters containing wool grease and suint are run into streams, pollution of the water results The desirability of preventing this nuisance as well as the value of the potash has resulted in attempts to dispose of the washings in some economical manner and they are usually evaporated to dryness and calcined When the material is calcined in closed retorts a considerable quantity of ammonia is obtained The cinder is then lixiviated and on evaporation the solution yields first chlorides and sulphates of potassium and sodium and finally a very pure potash which averages a little less than four per cent of the weight of the raw wool scoured

This mode of utilizing wool grease and suint is mainly practiced in France Belgium and Germany, and in these countries it is done chiefly to prevent the pollution of the streams Cheap fuel is very essential to a successful working of the process On a small scale it can not be carried on profitably and the wash waters are often run onto the fields as fertilizer

Potash in Seaweeds

A concentration of potash salts from sea water is reported as being effected by the giant seaweeds of the California coast These plants on drying are said to exude nearly pure potassium chloride and its recovery on a commercial scale has been suggested but so far as known has not yet been actually tried It is understood however that some potash is recovered from kelp elsewhere

A New Method of Exploring the Earth s Interior

By Dr Schames

For information concerning the nature of the earth s interior we have hitherto been dependent entirely upon the study of the propagation of earthquake waves If we suppose a plane to be passed through the earth s center and any two points of its surface as A and B

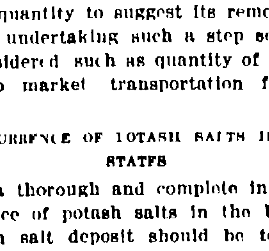


Fig 1—Earthquake Shock Travels from A to B by Three Paths Indicated by the Arrows

(Fig 1) this plane will intersect the surface in a great circle It has been learned by experiment that a shock originating at or beneath the point A is transmitted to B by three distinct waves which reach B at different instants It is assumed that one of these waves is propagated through the earth s interior approximately in the straight line AB and that the other two waves travel through the earth s crust in opposite directions following the curved paths indicated by the arrows The observed differences in the times of arrival of the three waves at B support Wiechert s hypothesis that the earth is composed of a metallic nucleus of density 8 4 surrounded by a shell of rock about 1 000 miles thick of density 3 4

Lowy and Leimbach have recently described two very different and more promising methods of exploring the earth s interior These new methods are based on the properties of electric waves which traverse insulators without diminution of intensity but are partly reflected and partly absorbed by good conductors of electricity Dry soil and rock may be regarded as insulators while subterranean water courses coal seams and deposits of metallic ores and salts are good conductors.

The first of the new methods is based on the reflection of electric waves and is applicable to depths of about 3 000 feet or less Electric waves emitted by an inclined antenna at A (Fig 2) are reflected by a water course coal seam or other conducting mass in the position indicated by M to the point B which is found by exploration with a receiving apparatus

The second method is based on the absorption of electric waves which are emitted by antennæ placed in borings about 1 000 feet deep and are received by apparatus placed in similar borings If waves emitted from the boring A (Fig 3) are received in B but not in C the inference is that the waves are absorbed by a water course or other conductor between A and C By this method the earth can be explored to a depth much greater than that of the borings for owing to the curvature of the earth s surface the middle point of the straight line which joins the bottoms of two borings which are 1 000 feet deep and 200 miles apart lies more than 3 000 feet below the surface Electric waves which have traveled 250 miles through the earth can be detected in the absence of any impediment to their propagation The feasibility of this method has been proved by practical experiments in a German potash mine

It is obvious that these new methods can be employed

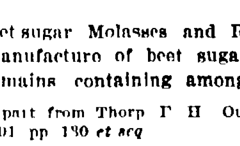


Fig 2—Electric Waves Reflected by Underground Stream

for proving or disproving the existence of Wiechert s metallic earth-core when the reach of subterranean signaling by electric waves has been increased to about 1,250 miles

An application of more immediate practical utility would be the systematic exploration of large territories for underground water The great plain of Hungary could be thus explored by means of 48 borings, each 1 000 feet deep The total cost of the 48 borings would not exceed $110 000 while a single boring, 3 300 feet deep would cost about $7 500 This method of exploration is especially well suited to tropical regions where the soil is drier and consequently a better insulator than elsewhere According to Wohltmann many subterranean water courses must lie hidden be-

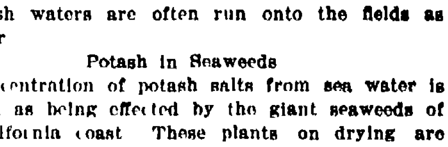


Fig 3—Electric Waves Absorbed by Underground Stream

neath deserts These new methods appear to be eminently well fitted for the discovery of these water courses and indirectly for the conversion of deserts into clusters of green oases watered by artesian wells. —*Umschau*

The Photographic Plate

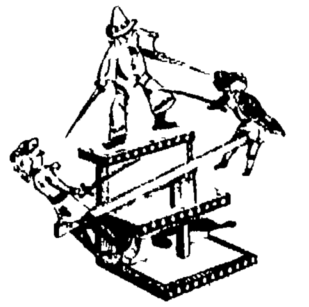
In the *Journal of Physical Chemistry* W D Bancroft states that the silver bromide grain is a complex of silver bromide gelatine, and water The process of ripening consists in changing the composition of the silver bromide grain toward an unknown optimum concentration There is no necessary connection between sensitiveness and coarseness of grain Chemical and optical sensitizers are depolarizers Gelatine acts as an emulsifying agent and as a sensitizer whereas collodion apparently acts only as an emulsifying agent The peptonization of silver bromide is merely a particular case of the general problem of the peptonization of any precipitate. The peculiarities of mixtures of AgCl, AgBr and AgI can all be explained on the assumption that each of these salts can form a continuous series of solid solutions with either of the two This is known to be the case for AgCl and AgBr It seems theoretically possible (by incorporating a suitable depolarizer or sensitizer with the silver bromide grain and using a suitable developer) to make an almost infinitely fast plate having a very fine grain

New Toys*

Interesting French Inventions

A THREE-HANDED DUEL

The novel French toy shown in the illustration may appropriately be called a three-handed duel The two assailants against whom the clown is forced to defend himself are mounted on a see-saw which is operated

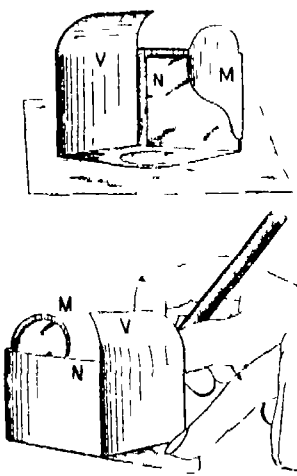


THREE-HANDED DUEL

by pressing alternately the two levers which project from the base The clown is armed with two swords and the combat continues until the owner of the toy wearies of the sport.

THE MAGIC DRAWING BOARD

The difficulty which is encountered in attempting to trace a line or to follow a motion which is seen by reflection from a mirror is strikingly illustrated by a new toy called the magic drawing board In New York such boards have been sold for some time under the name 'Wiggle-waggle Graph As the diagrams show the drawing board is really an incomplete box which lacks one side and has no top The remaining side *N* and the end *M* are lined with mirrors The end *V* is made of sheet zinc and its upper part curves

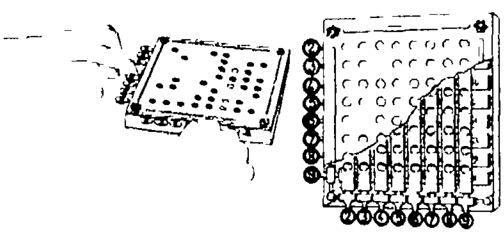


THE MAGIC DRAWING BOARD

over the box and prevents the draftsman who faces this end from seeing directly into the interior A large round hole is cut in the bottom of the box which is also of sheet zinc The box is placed on a sheet of paper on which three equidistant dots are marked just inside the circular aperture The draftsman facing the end *N* sees these dots as well as his pencil point only by double reflection from the mirrors *N* and *M* His task is to join the points by straight lines within a given time The problem may be varied by increasing the number of dots or by requiring the drawing of lines that do not meet but even in its simplest form it requires for its solution a steady hand a quick and correct eye a cool head and much patience and practice.

THE PYTHAGORAS A MATHEMATICAL TOY

The Pythagoras is a toy rather than a calculating machine Its inventor makes no greater claim for it than its utility in teaching children the multiplication table by pleasant and entertaining method The apparatus is a flat, square box the cover of which is perforated by 64 round holes arranged in square order The drawing of the apparatus shows eight keys marked with the digits from 2 to 9 on the left side of the box and also on the front By depressing simultaneously one key of each series the product of the numbers marked on the two keys appears in the round hole which corresponds to their intersection For example if key 5 on the left side and key 7 in front are depressed the number 35 appears in the sixth hole of the fourth row The mechanism by which these results are accomplished is very simple Each of the keys at the left side of the box is connected with a horizontal strip of paper marked with eight of the required sixty four products and each of the front keys is connected with a strip of metal pierced with eight



THE PYTHAGORAS

holes equal in size to the holes in the lid of the box When none of these keys is depressed neither these holes in the metal strips nor the numbers on the strips of paper are vertically beneath the holes in the lid Depressing the left hand key brings the required number as well as seven others under holes in the lid but these are still covered by the metal strips until the depression of one of the front keys brings the hole in one of these strips under the hole in the lid and thus reveals the required product which is directly beneath both of these holes

NEW FRENCH FLYING TOYS

The popular interest in aviation is reflected in the number of flying toys offered for sale in Paris and elsewhere Three of the newest of these toys are here pictured The Aeromains (Fig 1) is a little four bladed screw propeller cut from a thin sheet of celluloid It has a hole at its center and is operated by placing it on a peg and a little celluloid disk at the end of a rod and rolling the rod rapidly between the hands as the illustration shows The rapid rotary motion thus imparted to the light propeller causes it

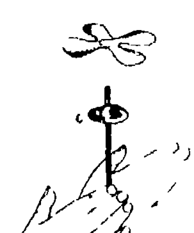


FIG 1—THE AEROMAINS

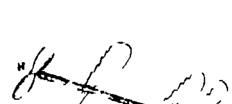


FIG 2—THE DEMOISELLE

to rise in the air and lively sport will be afforded by the attempt to catch it on the rod as it settles down again The Monte-au-ciel (Fig 3) is of similar construction but the propeller is stiffened by a rim and is launched by pulling a cord wound round the rod which occupies the interior of the hollow handle of the toy Hence it rises much higher than the hand driven propeller

The Demoiselle (Fig 2) is a real monoplane with

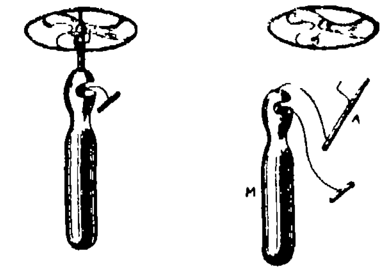


FIG 3—THE MONTE-AU CIEL

a screw propeller *H* which is attached to a stout India rubber cord concealed in the tubular axis This cord is twisted by turning the propeller through about a hundred revolutions The demoiselle is held in the inclined position shown in the illustration with one hand while the propeller is held with the other The propeller and the frame of the machine are then released simultaneously The untwisting of the elastic cords spins the propeller rapidly and the demoiselle if properly launched accomplishes a long flight An interesting aviation contest may be carried out with a number of demoiselles and as many players

A MACHINE FOR WINDING UP TOY AEROPLANES

Toy aeroplanes which are now offered in great number and variety are usually driven by twisted rubber cords The aeroplane is wound up by turning the

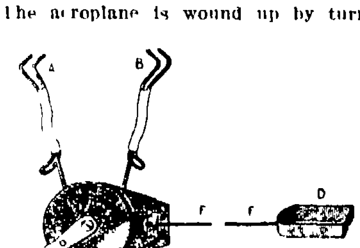


FIG 1

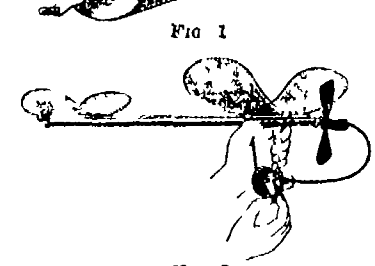


FIG 2

A MACHINE FOR WINDING UP TOY AEROPLANES

propeller backward through from 150 to 300 revolutions according to the length of the elastic cord This operation is tedious and when the aeroplane is nearly wound up it is not easily kept in the proper position for launching

The winding is greatly facilitated and accelerated by the employment of the little machine herewith illustrated The aeroplane is held by grasping its frame with the jaws *A* and *B* (Fig 1) of a pair of pincers attached to the machine which consists essentially of a pinion driven by a crown wheel and crank A flexible transmission *F F* connects the pinion with the spring clamp *D* by which the propeller shaft is grasped The method of using the machine is shown in Fig 2 The flexible transmission is so constructed that it forms a loop and stops the operation when the torsion attains a certain value less than the elastic limit of the India rubber which is thus safeguarded against rupture

* Collected from *La Nature*

Legal Operations of the Department of Agriculture

Cases reported to the Attorney-General for prosecution under the several laws administered by the Department of Agriculture numbered 1,738 twice as many as the year before More than $40 000 in fines and costs were assessed hundreds of tons of misbranded foods and drugs were forfeited

Food and drug cases numbering 990 were reported 766 for criminal action and 224 for seizure proceedings. Of criminal cases, 246 resulted in convictions, 8 in verdicts for defendants, 96 were dismissed, 152 were pending in courts at the close of the year and 252 remained under consideration for future action No leniency was shown in cases involving unfit foods or dangerous drugs. Sixty cases left over from previous years were terminated. The total of fines collected under the food and drugs act during the year was $11 049 31 Of the cases reported for seizure proceedings 132 resulted in forfeiture decrees while 50 were pending at the close of the year In addition 43 shipments were forfeited under seizures of previous years

Since January 15th 1910 when the law work of the Forest Service was placed immediately under the solicitor 105 cases were reported for prosecution under the acts protecting the national forests while 565 cases of contested claims to lands within the forests were disposed of

Under the twenty-eight-hour law 438 cases were reported, more than twice as many as during the preceding year In 139 cases closed $16,500 in penalties was recovered, with $2,919 35 costs, 19 cases out of 158 tried resulted in favor of defendants 29 cases were dismissed for insufficient evidence 559 cases were pending at the close of the year To carry out the present intent of Congress in passing the act which was framed to secure the humane handling of live stock in transit it would seem says the Secretary of Agriculture that an additional provision should be incorporated therein requiring carriers to maintain a reasonable minimum speed on all stock trains

Under the live stock quarantine laws 148 cases were reported 20 cases were disposed of with fines amounting to $2 970 Fifty two violations of the meat inspection law were reported 18 cases gave convictions, 8 were dismissed and 26 are pending Two cases were reported under the Lacey act for the protection of game 1 was abandoned because of difficulty of proving interstate shipment the other is pending Four cases came over from the previous year In 2 the grand jury failed to indict, in the other 2 fines were assessed

The Aims of Astronomy of Precision*

A Resume of Modern Methods

By S S Hough

The science of precise physical measurements is one which does not readily appeal to those not immediately concerned either with the methods or results. An authoritative statement that the sun's distance from the earth is 92 880 000 miles may excite wonder but scarcely more than will the statement that it is approximately 93 000 000 except in the mind of those who are in some measure acquainted with the laborious processes by which the two extra figures are derived. In fact I have not infrequently heard the methods of observation used described by some such epithet as "hair splitting." For this reason I think I cannot do better to-night than to describe to you without entering into technical details of the methods employed some of the aims and objects to which modern astronomy of precision is devoted and which render essential the very highest refinements that human ingenuity can devise.

Perhaps the primary reason why astronomy appeals to the popular imagination in a higher degree than other sciences is that astronomy is *par excellence* the science of prediction. True the days are now past when an astronomer was regarded except by the most ignorant as gifted with supernatural powers and capable of predicting events that can have no conceivable relationship with the objects of his researches, or when an unscrupulous astronomer could utilize his powers of prediction for imposing on the world at large in the face of the criticisms of fellow workers in collateral branches of science. Nevertheless it is only necessary to point to any of the leading almanacs to establish the undoubted claim of astronomy to a considerable predictive capacity in its own legitimate sphere. These almanacs prepared in advance give from day to day the positions of the sun and moon, the phenomena of eclipses, and various other data with an accuracy which can only be called in question by the most refined tests available to astronomers.

How then has astronomy acquired this faculty? The answer to this question is—at least primarily by continuous and patient observation using always the most refined methods of physical measurement available.

A well devised scheme of observation is sooner or later bound to lead to the detection of laws governing physical phenomena if such laws exist. Thus it was the planetary observations of Tycho Brahe which led to the detection of the laws of planetary motion associated with the name of Kepler.

Once such laws have been established and the necessary initial data secured the science of astronomical prediction would for the future devolve on the mathematician rather than the astronomer were it not for two sources of uncertainty with which the astronomer must continue to concern himself. It is evident on one hand that we cannot infuse into our predicted phenomena greater precision than that derived from the initial data themselves dependent on imperfect observations. However well the laws governing planetary motions may be understood the predicted position of a planet to-day depends on its observed position at some earlier epoch or epochs; and the fallibility of the observations made at these earlier epochs will not only pervade all future predictions but will inevitably increase in amount as the epoch of prediction recedes from the epoch of observation. For this reason if the standard of accuracy of prediction is merely to be maintained and the growing requirements of science will scarcely rest contented with this—continuous observation must be maintained and the data on which predictions are based revised from time to time.

I have dealt so far only with the effects of the unavoidable inaccuracies of observations even when pushed to their utmost refinement as influencing results of prediction. A second consideration of even greater importance is the validity of the laws associating the predicted with the observed phenomena. I may illustrate my point again by reference to the laws of Kepler. It is now well known that these laws are only rough approximations to the actual truth and that though they might serve as a useful basis for prediction over a short interval a few years at most would suffice by showing a rapidly increasing departure between the observed and predicted positions of the planets to indicate that these laws require amendment.

That the disclosure of direction which this amendment should take followed so soon on the original discovery of Kepler's laws was due to the genius of Newton who showed that the theory of universal gravitation propounded by him not only adequately accounted for the laws enunciated by Kepler and pointed to their imperfections but served to co-ordinate as due to a single cause even more recondite phenomena such as the leading inequalities in the motion of the moon, the precessional motion of the earth, and the phenomena of the tides. This theory further reduced to order those astronomical vagaries the comets, showing that so long at least as they remained within the precincts of the solar system their motions were governed by it while observations of double stars have established beyond question that even remote parts of the universe are still subject to the same laws.

The dynamical laws propounded by Newton which to-day virtually form the basis of all astronomical prediction enable us to trace back as well as to trace forward the history of the solar system, and to confront modern observations with historical records. Needless to say in but rare instances do these records possess the necessary *elements of precision to strengthen the existing data required* by the astronomer; but there are important exceptions. For instance a very small uncertainty in the "elements," which in conjunction with Newton's laws govern the motion of the moon will produce by lapse of time a large change in the comparatively small area of the earth's surface over which a total eclipse of the sun is visible as such. Thus a record that a particular eclipse was seen as total in a given locality becomes an observation of precision, provided only the chronological date at which the eclipse occurred can be traced with sufficient certainty to insure the identification of the eclipse concerned.

The confrontation of modern with historical observations of such character has served to establish beyond question the high degree of accuracy with which the laws of Newton represent the motions within the solar system and their trustworthiness as a basis of prediction for years perhaps for centuries to come. It is however on various grounds quite certain that these laws in themselves are not absolute far reaching though they are and that they in turn like those of Kepler must be superseded by laws still more exact.

Until such laws are discovered there will always remain an element of uncertainty apart from that due to the initial data affecting all predicted phenomena—an uncertainty which can only be removed when the phenomena cease to be prospective and when they can be confronted with later as well as with earlier observations.

The fact, however that the laws of gravitation yield such a close representation of the observed motions within the solar system throughout historic time renders the detection of a departure from these laws a question of extreme delicacy but none the less essential if prediction is to be secured for long periods in advance.

I have selected my illustrations largely from the solar system chiefly on the grounds that thanks to the Newtonian laws, it is here that in spite of the immense mathematical difficulties which have had to be faced astronomical prediction has attained its greatest triumphs. I wish now to divert attention to the stars. In so far as these form the fiducial points to which the motions of the planets and other members of the solar system are referred it is essential that the positions of a limited number at least should be determined with the highest possible accuracy. Any uncertainty in their positions will undoubtedly be reflected in the positions of the planets, and will constitute one of those sources of error so liable to increase with time and render efforts at prediction if not entirely nugatory at least partially ineffective.

The universe of so called "fixed stars" is not invariable in aspect though its changes for the most part are of so minute a character that they can only be surely detected either by the most delicate measurements or by their cumulative effect over long intervals of time. It is chiefly through a study of these changes that our knowledge of the stellar universe has been acquired in the past and it is largely to similar means that we look for an extension of this knowledge.

Among changes which lend themselves to observation for this purpose we may enumerate:

(1) Changes of the intensity of the light of the stars. The origin of these changes except in a few instances remains obscure. In certain cases, however notably in the case of variable stars of the Algol type a satisfactory explanation of the observed phenomena has been found in the motions of a system governed by laws similar to those operating in our solar system of which the visible star forms a constituent member.

(2) Changes of position due to orbital motion in binary or multiple stars. Where both components of a binary star are visible these changes readily admit of direct measurement. In other cases the existence of a companion is inferred to account for regular periodic changes of position of the visible component, though this companion cannot be seen either on account of intrinsic want of light or on account of its close proximity to the primary and the consequent incapacity of our telescope to render the two visually distinct.

These changes are of interest as affording evidence of the validity of the Newtonian laws in systems other than the solar system.

The changes to which I have so far referred are changes which affect isolated stars or groups of stars, but which do not occur at least to a sensible extent, in the generality of stars.

I come now to the changes of position due to the earth's orbital motion which, on the other hand may be expected to influence all stars in common. Even where, as in the cases I have already spoken of their influence is obscured by orbital motion within the system, when once this orbital motion has been thoroughly examined its laws deduced, and due allowance made for it by computation we might expect to find the effects of the earth's motion still apparent.

The earth in its orbit round the sun approximately describes a circle of 186,000 000 miles in diameter and its successive positions in space at intervals of six months are separated from one another by this extent. But experience has shown that recurring changes in the relative positions of the stars, as viewed at intervals of six months—that is to say, from two different points of the universe separated by this vast distance—can only be detected in the case of a limited number of stars, and *then only by the application of the most delicate methods* of measurement specially designed to bring these changes to light.

To the Cape Observatory and its former director Henderson (1832-4), belongs the credit of first producing trustworthy evidence of the existence of any fixed star, *for which these changes could be unmistakably detected,* and which therefore, was not too remote from the solar system to permit of its distance being at least roughly determined in comparison with the diameter of the earth's orbit. Henderson's discovery has since been fully confirmed by later observers and other stars likely to yield tangible results have now been examined. As illustrative however of the evasiveness of the quantities sought, and the excessive labor by which only they can be derived, though the problem of stellar distance has always been in the forefront of astronomical interest and has attracted the attention of several able observers, the number *of stars for which well-determined parallaxes have* been published up to the present day does not exceed some 400. This number is quite insignificant in comparison even with the number of stars visible to the naked eye without telescopic aid. Moreover the stars investigated have been in general, selected on the grounds of some *a priori* probability of their possessing a measurable parallax either on account of apparent brightness or on account of their large apparent motion and for this reason they can scarcely be regarded as typical of the generality of stars.

In order then to gage the depths of the visible universe it would appear imperative that our base line must in some manner be extended. The distance of 186,000 000 miles through which we are carried in the course of a single half year by the orbital motion of our planet round the sun is so small in comparison with interstellar distances as to give rise to changes in the apparent relative positions of stars which, except in the most pronounced instances are so insignificant in amount as to defy detection even by the most refined processes of measurement we possess.

How then can such an extension of our base line be attained? I have already pointed out that the so called fixed stars are not truly "fixed," but that on close observation it is found that each star has an apparent motion either peculiar to itself or shared by other neighboring stars which with it constitute an independent system. I refer primarily to the visible motion transverse to the line of sight.

If then our sun, as we may reasonably suppose, is itself a member of the stellar universe it may be anticipated that it too will not be at rest, but will be moving forward in space and the visible motions will be those due to the combined effects of the motion of the sun and stars.

That the apparent motions of the stars were not entirely fortuitous but that they could at least partially be co-ordinated throughout the sky as the visible manifestations of a single phenomenon, viz a translatory motion of the sun with its system of planets through interstellar space was first pointed out by Sir William Herschel who further indicated that the point of space to which this motion was directed was situated in the constellation "Hercules."

Before proceeding to the further consideration of this solar motion I wish first to point out to you how its existence at once suggests a means of "extending our base line" for the purpose of gaging these interstellar depths. I have refrained from any numerical estimates of the amount of this motion as this involves philosophical questions into which I do not desire to enter to-night; but in order to fix our ideas it is necessary for me to give you some notion at least of the order of magnitude. It is now possible to state with some certainty that the speed of the sun's motion relatively to the stars as a whole amounts to about twenty kilometers per second, and that the space traversed in a single day therefore amounts to rather more than 1,000 000 miles, that in a year to about 400,000,000 miles. Thus the stars, as seen on two occasions a year apart may be considered as viewed from two points in space separated by this length, and it only requires lapse of time in order to increase the length to an almost indefinite extent.

The great scheme for the photographic mapping of the heavens at present being carried out on an extensive scale by means of the co-operative efforts of the leading observatories of the world will shortly furnish a highly accurate delineation of the skies as seen at the commencement of the twentieth century. This alone has called for concentrated effort extending over some twelve years at least, while it would even now scarcely be safe to say that another ten years will see its completion. An immediate repetition is scarcely to be contemplated, though a subsequent repetition at some future epoch, which may be agreed on by astronomers, forms an essential part of the programme as originally introduced.

When this scheme is completed in its entirety very ample data will be available for the discussion of stellar distribution by the methods I have suggested to you.

In the meantime, however, in such tentative attempts as have been made to fathom the secrets of the universe by means of the study of stellar proper motion, it has been necessary to rely on early recorded exact observations. It will be clear from what I have already explained to you that it is the earliest trustworthy records in comparison with the most up-to-date available which

* From the presidential address delivered before the Royal Society of South Africa

will yield the greatest length of base-line, and consequently the most trustworthy results For this reason the majority of the discussions hitherto attempted have been based on the catalogue of Bradley dependent on observations made by him at Greenwich between the years 1750-62 This catalogue contains the places of some 3,000 stars observed with a precision far surpassing any similar previous observations, and comparing favorably with the best modern catalogues The stars selected by Bradley are fairly uniformly distributed over the portions of the sky accessible to him, viz from the North Pole to 30 deg south of the equator

Unfortunately no early catalogue of stars of even approximately similar precision exists for the remaining region of the sky between 30 deg S dec and the South Pole, and the absence of exact knowledge of these regions for the earlier epochs has always hampered these discussions

The discussions I refer to have generally had as their immediate objectives

(1) The determination of the precessional constant i. e the annual amount by which the earth s axis of rotation changes its position in space and

(2) The determination of the speed of the solar motion and the position of the solar apex i. e the point in the heavens toward which the sun s motion is directed

The discrepancies in these quantities found by different investigators, either starting with different data or utilising different methods for the combination and discussion of the same material had long been a puzzle to astronomers. The key to the situation was at length furnished by Prof Kapteyn of Groningen who in an epoch-making paper read before the British Association in Cape Town, first pointed out that the apparent motions of the stars indicated not merely the existence of a single solar apex but that there were two separate regions of the sky toward which a preference was shown by the directions of motion of the Bradley stars

This was a phenomenon which could not be explained by a simple motion of translation of the sun as evidently the sun s motion could not be directed to two different points simultaneously and the only feasible explanation was that the stars consisted of two groups and that the motion of the sun relatively to one of these groups differed from its motion relatively to the other or that, though the stars appeared intermingled in space they possessed an independent relative motion which might be regarded as located in one group or in the other but which was shared by all the stars peculiar to the group

The theory of the existence of two streams or drifts of stars thus put forward by Kapteyn has since received full confirmation by other investigators notably by Eddington who based his examination on the early observations of Groombridge and by Dyson who limited his discussion to a selected list of stars possessing considerable proper motions

Recent investigations at the Cape have led us to examine in somewhat more minute detail the proper motions of the Bradley stars, with the result that though the phenomena first noticed by Kapteyn stand out as the most prominent feature, certain subsidiary features of no less importance have been brought to light

I have concerned myself hitherto only with the visible motions of the stars transverse to the line of sight, as derived by the older methods of measurement The introduction of the spectroscope into astronomical research has opened up vast new fields into which, so far as they relate to the chemical and physical constitution of the sun and stars it is not my purpose to enter to-night. What I wish rather to emphasize is the value of this instrument as a supplement to the older methods in relation to the geometrical astronomy of position

In accordance with the principle laid down by Döppler the wave-length of light received from a source which is either receding from or approaching a receiver will appear to be modified by an amount dependent in a known manner on the velocity of approach or recession If the receiver takes the form of a spectroscope which permits by any means, direct or indirect of the measurement of the wave lengths and the normal wave lengths of the lines under examination are independently determined by laboratory investigations the difference between the observed and the normal wave lengths will thus afford a means of measuring the velocity of approach or recession of the source of light

Of the precautions necessary to ensure precision it is not my purpose to speak to-night The large spectroscope of the Cape Observatory which we owe to the munificence of the late Mr Frank McClean was from the outset constructed with due regard to these precautions so far as they could be foreseen for the purpose of determining with the greatest accuracy attainable the radial velocities of stars The instrument has been already successfully used and its capabilities have been established in an investigation of the aberration constant of light as depending on the apparent variations in the radial velocities of stars resulting from the earth s orbital motion

From a relatively short series of observations discussed by my colleague Dr Halm this constant has been derived with a precision not inferior to that attained by the best series of older observations and the capabilities of the method are yet far from exhausted

At the present time the instrument is being devoted to a series of observations of all such stars as are accessible in the southern skies the spectra of which present sufficiently pronounced features to admit of measurement primarily with the view of ascertaining what evidence can be derived from a study of the radial velocities in regard to the systematic structure of the universe

A year or two must elapse before the present observing programme is completed but a preliminary discussion of the observations already secured in combination with the published results derived from similar observations in the Northern Hemisphere has revealed the existence of anomalies similar to those found from the study of the transverse motions—anomalies which can only be reconciled with the two-drift hypothesis put forward by Kapteyn by the further hypothesis that though both drifts pervade the whole sky they are not similarly distributed throughout it

At present through scantiness of material from a study of the radial velocities we have been able to do little more than discriminate between the two halves of the sky which contain respectively the greatest and the least proportion of second drift stars It is however a fact of some significance that the former corresponds very closely with that hemisphere which contains the Milky Way suggesting the phenomenon that Kapteyn s second drift might be identified with the galaxy It was with the view of examining this suggestion in the light of the evidence which could be secured from the transverse motions of the Bradley stars that the discussions I have sketched to you to-night were undertaken by Dr Halm.

While they have established almost beyond question the rough features of distribution demanded to reconcile the radial velocity determinations, they further point to an even more detailed correspondence between the distribution of galactic stars and the distribution of stars of the second drift leaving but little doubt as to the identity of this second drift with the galaxy It is this second drift which exhibits evidence of structural units As regards the Milky Way the mere appearance on any fine night affords evidence of a similar character and it is on this account that we have been able to identify the Milky Way with the second drift rather than the first

The significance and origin of this structure are as yet obscure but the more its details are elucidated and the essential features established the nearer are we to an answer to the question What is the Milky Way?

To revert to my original text I have endeavored to point out to you the methods of research by which an answer is sought to this and similar questions and to explain to you the reasons why the highest precision attainable is a *sine qua non* in the conduct of such research Thus it is that the study of the large scale phenomena of the universe resolves itself frequently into a study of the minute detail of instrumental appliances on which must be brought to bear all the knowledge that can be derived from other branches of scientific work The geologist helps us in the selection of stable foundations on which the engineer may erect our large instruments Chemistry and physics in our photography our optical and electrical appliances are of daily application while one of the most valued accessories in almost all methods of precise measurement is the spider s web we devise from zoology

Astronomy in its turn has done much in the past and in the future will doubtless do more to assist the development of collateral sciences Thus the geologist cannot afford to ignore even if he does not accept as conclusive the evidence furnished by astronomy as to the nature of the earth s crust Exact measurements of space and time as conducted in physical laboratories are for the most part conducted by methods first designed to suit the requirement of astronomical precision while in the sun and stars chemical phenomena which may be studied with the aid of the spectroscope are taking place on a scale far surpassing anything that can be produced in the laboratory

The value of free intercourse between workers in the various branches of science is certainly indisputable and I wish to close my address by reference to the opportunities which our society can afford in this respect Devotees even of applied and still more of pure science in a young country are necessarily few in number and scattered A large proportion of these will in the early stages of their career have been in close association with one or the other great centres of scientific activity of the world and to such a feeling of scientific isolation almost amounting to exile and consequent lack of stimulus is almost inevitable Important as are our publications it is even more through our monthly meetings and the promotion of personal intercourse that the society can help in it primary duty of the advancement of natural knowledge in South Africa

Abandonment of the Weekly List of Patents

Early in the present year we transferred to the columns of the SCIENTIFIC AMERICAN SUPPLEMENT *the list of patents which formerly appeared each week in the* SCIENTIFIC AMERICAN *It was felt that the amount of space devoted to the list an amount which increased year after year could be better devoted to interesting reading matter We asked our readers what they thought of the change A number of protests were received but a far greater number of approving comments*

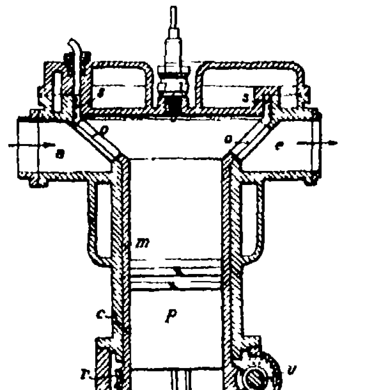
In view of these circumstances the publishers have decided that if the readers of the SCIENTIFIC AMERICAN *did not want the weekly list of patents the readers of the* SCIENTIFIC AMERICAN SUPPLEMENT *were no more in favor of it*

This therefore will be the last list of patents which will appear either in the SCIENTIFIC AMERICAN *or the* SCIENTIFIC AMERICAN SUPPLEMENT

The Renault Valveless Explosion Motor

THE excellent performance of the Knight valveless motor, which has been adopted by the Panhard-Levassor firm and several other automobile builders, has incited other inventors to endeavor to eliminate the admission and exhaust valves, which are costly and fragile, and which diminish the efficiency of the motor by introducing idle spaces.

The Renault firm, of Paris, has recently patented a valveless motor the construction and operation of which are illustrated by the accompanying diagram of one cylinder The piston *p* moves in a cylinder *m* which rotates on its axis inside the fixed cylinder *c* with an angular velocity equal to one-eighth that of the crank shaft The rotation is produced by the endless screw *v* and the helically geared wheel *r* Each cylinder is terminated above by a conical extension This part of the outer cylinder has two openings *a* and *e* which constitute the admission and exhaust ports, and are placed at an angular distance from each other which is determined by the proper regulation of the motor The conical head of the inner cylinder has four openings *o* spaced at intervals of 90 degrees which successively unmask the ports *a* and *e* as the cylinder rotates These openings are bounded laterally by generating lines of the cone and above and below by the horizontal planes which limit the conical portion of the cylinder



THE RENAULT VALVELESS EXPLOSION MOTOR

Leakage from the inner cylinder is prevented by the pieces *ss* The igniter is placed at the center of the removable base of the cylinder—*Le Génie Civil*

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Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co 361 Broadway, New York.

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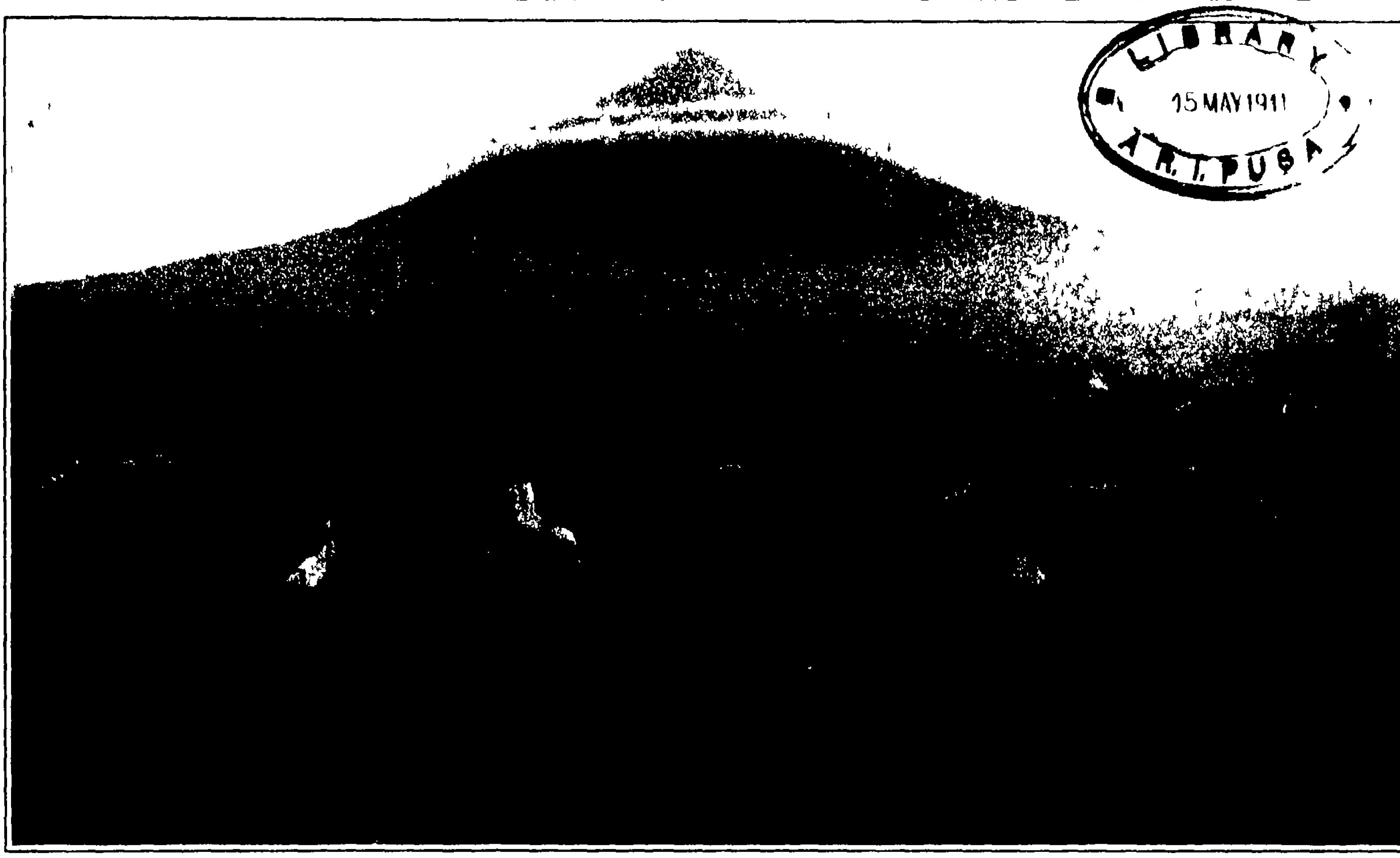

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VIEW OF THE VOLCANO OF AGUA FROM A NEIGHBORING TOWN

RUINS OF CHURCHES AND PALACES OF ANTIGUA DESTRUCTION WROUGHT BY THE VOLCANO OF AGUA

ANTIGUA—A CENTRAL AMERICAN CITY WITH A WONDERFUL PAST—[See Page 231]

The Formation, Growth, and Habit of Crystals*

Modern Views of Crystallography

By Paul Gaubert, D Sc, Assistant in Mineralogy at the Natural History Museum, Paris

A CRYSTAL arouses the interest of the observer not only by the regularity of its forms the perfection of its surfaces and angles its transparency and its brilliancy but also by the manner in which it grows, heals its wounds is dissolved and modified under the influence of the inclosing medium To some authors the crystal from certain points of view appears analogous to living forms and seems to undergo a sort of evolution

Its formation its growth the variations of the faces under the influence of the inclosing medium have been the object of numerous researches which have greatly modified our conceptions regarding them The purpose of this article is to show the present state of our knowledge concerning these diverse and interesting questions of crystallogeny

I

As early as the seventeenth century Leeuwenhoek who examined under the microscope everything that in his time lent itself to this line of observation followed the formation and growth of the crystals of various substances (as sugar tartar sea salt etc) He was led to conclude that the cubic crystals of sea salt are formed of other minute cubes themselves made up from cubes the existence of which one has to accept through analogy with what is seen since they are invisible under any magnifying power Later Baker Ledermüller and others also examined under the microscope the branched and varied forms that appear when a substance crystallizes on a sheet of glass but it is to Nicholas Le Blanc that we owe the first systematic and effective researches in crystal genesis and particularly in the variation of the form In his very interesting work De la Cristallotechnie he gives methods for the preparation of crystals and in particular does he set forth the process of renewing the solution of feeding the growing solids that they may attain a relatively considerable size

In what form do we see the crystal with the aid of the highest magnifying power? Does it present from the first the form that it will have later? The biologists were the first to take up the matter of the formation of the crystalline germ that is, of the form which it presents at the instant when it first becomes visible and most of them have admitted the existence of an embryonic state or a state in which the constitution and form are different from that of the crystal properly called although this idea has been contradicted by Frankenheim to whom we owe numerous crystallogenic observations Vogelsang in 1867 took it up again and made numerous ingenious and varied experiments to show its correctness His observations are generally exact but he has unfortunately misinterpreted them To show the embryonic state of the crystal Vogelsang tried to make the bodies crystallize under special conditions with the purpose of retarding their formation so as to enable him to observe all the steps of development With this purpose in view he added to sulphur solution a viscous body Canada balsam There were produced little spheres to which Vogelsang gave the name of globulites and which were thought to represent an embryonic stage These globulites unite to form particular groups each of which has received a special name and at the expense of which the crystal would be produced only at a later stage

Moreover Vogelsang rests his experimental researches on observations made with crystallites of varied forms existing in a few rocks rich in silica and more or less vitreous and in the slags of blast furnaces but as was later shown by M O Lehmann who made numerous researches on the formation of crystals these globulites are but drops supersaturated with sulphur and consequently have nothing in common with the crystalline state

Brame as well as Vogelsang studied sulphur but in a molten condition He observed little supermelted drops (utricules) to which he attributes a considerable role in crystallization His ideas differ from those of Vogelsang but nothing in his experiments substantiates the existence of an embryonic state.

The observations of M O Lehmann have shown that the crystal possesses from the beginning a form identical with that which it has when it has attained larger dimensions T V Richard and E H. Archibald have employed the cinematograph to follow out the formation of the crystal and obtained only figures of completely formed individuals.

I myself have made a great many experiments, and have always found that the first visible particle had all the properties of the crystal It is nevertheless not to be disputed that in some cases there takes place what Vogelsang and his predecessors have observed with sulphur or other bodies but who worked with supersaturated drops or amorphous particles or little spherulites of unstable form which later underwent modifications into more stable forms and the normal development of which can then be followed

Nevertheless in spite of the observations of Frankenheim O Lehmann and others the idea of the embryonic state of the crystal has not disappeared from science and the hypothesis of Vogelsang, supported by De Schoen Cartaud and others resting on misinterpreted observations still finds some credit.

II.

When the crystal is once formed—that is, becomes visible under the microscope—how does it grow? Several cases may be presented First the mother liquid is in a state of rest, the cooling or evaporation is extremely slow, and the crystalline particles are built up by diffusion alone In this case the growth is too slow to be constantly followed under the microscope In the second case the liquid is cooled or evaporated with such rapidity that the quantity of matter deposited on the crystal produces an enlargement microscopically visible Movements in the liquid are thereby set up It is an established fact that currents called currents of concentration passing over a crystal deposit a thin coating of substance followed by a second and so on until for example one can see on a crystal of lead nitrate having a diameter of half a millimeter as many as twelve of these successive layers deposited If the process were suddenly interrupted and the crystal examined any observed face would not be a plane but would show a sort of step arrangement of which the highest step would indicate the point of contact of the current of deposition

These successive deposits have no interspaces and the crystal may be perfectly transparent If the crystal of lead nitrate is however subjected to the influence of two or of several currents of concentration the corresponding coatings laid upon it start from different points in the periphery and may not be of the same thickness. Ordinarily they do not join exactly at their point of meeting In this way are then produced inclusions and the crystal is no longer transparent but becomes milky On a glass plate it is easy to produce at will a transparent or milky crystal of lead nitrate In the experiment it is necessary to agitate the crystal very slightly with a needle in order to subject it to the influence of one or several currents

These concentration currents produce other peculiarities (vicinal faces etc) which it would take too long to describe in detail I shall confine myself to calling attention to the influence they may have upon the faces of the crystal The introduction of matter to one face only of a crystal causes it to develop unequally and since all crystals of the same bath or magma are not influenced in the same way they may present a number of different forms The crystals formed at the bottom may be different from those which are deposited on the side walls or at the surface

III

If these concentration currents can completely change the habit of a crystal by producing elongation in one direction the nature of the faces is not modified an octahedral crystal always appears in octahedrons But there are two other influences which modify the faces One of them is the rapidity of crystallization the other the constant absorption of foreign matter by the crystal in process of growth Still other factors may intervene, but they are only indirectly concerned

It has long been known that crystals formed rapidly possess simple faces, while those which have grown slowly are more complicated Thus in nature the crystals rich in inclusions sometimes of large size, are poor in faces while the small crystals of the same substance but transparent, are generally limited by a large number of faces. These differences are due to the rate of crystallization the influence of which has been known by the experiments of Frankenheim, Lecoq de Boisbaudran O Lehmann, and myself In rapid crystallization the crystals have faces with simple symbols in slow crystallization these same simple faces persist, but the angles and edges have been truncated and beveled, giving rise to new facets, and I have shown that in certain cases these facets make their appearance always in the same order With varying rates of crystallization the dominant forms obtained in the case where the crystallization was rapid persist with more or less extensive development, but it may be otherwise in the case where the faces are modified by the regular absorption by the crystal during the growth of foreign matter added to the mother liquor This fact is easily made evident, as I have demonstrated by adding a little coloring matter

Rome de l Isle and Berniard have observed that the crystals of sodium chloride formed in urine are regular octahedrons instead of cubes such as crystallize from a pure mother liquor Vanquelin and Fourcroy showed later that this curious modification is due to the urea present. Boydant also established a few phenomena of the same class and tried without success to ascertain why the mere presence of a foreign substance can be thus effective

P Curie developed a remarkable and attractive theory which apparently furnished the key to this curious modification He claims that the capillary action existing between the liquid and the crystal intervenes an effect varying with the nature of the faces belonging to the diverse forms and with the nature of the liquid. Basing his belief on Gauss's theory of capillarity he concludes that such faces develop or require the minimum expenditure of capillary energy The dominant forms must consequently be conditioned by those faces the constant capillarity of which is the least The addition of a foreign substance altering the different capillary constants may consequently induce modifications of form

It appears indeed that the capillary forces must act, but up to this time there is no fact known which proves that they intervene sufficiently to modify the forms in spite of the experiments of M Berent carried out in the laboratory of Sohncke moreover, I shall describe later an observation showing that they are without influence.

IV

The crystals of one substance rarely form synchronously with those of another dissolved in the same mother liquid and it is on this property that chemists base their action when they attempt to purify bodies by repeated crystallizations but there are exceptions as in the well known coloration of hydrated nitrate of strontium by extract of logwood which was accomplished by Senarmont. Since then M Lehmann and I have proved a few other cases of coloration of crystals by artificial organic dyes

By making use of the artificial coloration of crystals so as to indicate the presence of foreign matter which has crystallized with the colorless substance I have been enabled to show that the absorption caused modification in form

The absorption of foreign matter by crystals in process of formation is accomplished in two different ways First the coloring matter enters into the composition of the crystal whatever may be its degree of dilution and is shared between the crystal and the liquid second the coloring matter is taken up by the crystal only when the liquid becomes saturated

The two processes may go on simultaneously The study of certain properties of colored crystals particularly polychroism and the law of division shows that the coloring substance in the first case is found in the crystal in the same state as in the liquid, in the second on the contrary the coloring matter is in the crystalline state and we have to do then with a regular grouping of the crystalline particles of the colorless substance with those of the coloring material added to the mother liquor

Lead nitrate is colored by methylene blue in the second manner it appears in cubic crystals with the triglyphic striæ of pyrite instead of in octahedrons The modifications in the crystals of this salt produced in a mother liquor which holds methylene blue in solution, show that capillarity does not intervene to produce them. Indeed, in a solution depositing lead nitrate and saturated with methylene blue, without, however giving crystals of this latter substance, the crystals of the nitrate are not at all modified They are in octahedrons and colorless, but as soon as the coloring matter begins to crystallize synchronously with them the cube faces appear and finally are formed to the exclusion of all others. Nevertheless, the surface tension can not have been changed since the quantity of methylene blue has remained the same in solution. An interesting fact is the inequality of absorption of the foreign matter dissolved in the mother liquid by the different faces of the crystal. Thus, on the octahedral faces of the lead nitrate the methylene blue is not at all deposited, but only on the faces of the cube and the pentagonal dodecahedron. Similar examples can be cited which explain the ap-

* Translated for the Smithsonian Institution's Annual Report from Revue Scientifique, Paris, 48th year No. 8, January 15th 1910

pearance, frequent in minerals known as hour-glass structure. In the case of cubic crystals of all the possible faces it is only those which absorb the foreign matter which will develop

The idea which first comes to mind is that the molecular structure of the crystal plays an important part in this synchronous crystallization It is not so at all, different foreign substances may be absorbed by different faces and in such cases the habit of the crystal is dependent on those diverse substances If one causes the colorless substance to crystallise in a solution containing two colors each one giving characteristic forms the crystallizations thus obtained will be the two combined forms so that one and the same crystal is composed of pyramids or of prisms of different colors Thus the crystals of urea nitrate colored by methylene blue and picric acid show if the crystallization has been carefully conducted yellow triangular prisms corresponding to the faces *g* and *h* and blue triangular prisms corresponding to the prismatic faces *m* of the monoclinic system

Not only may foreign crystalline matter be absorbed but also the liquid matter added to the mother liquid and even the molecules of the latter may also pass regularly into the crystal to modify its form I have been able to show this fact by crystallising phthalic acid in a solution containing ethyl alcohol[1] This explains why a crystal obtained from different solvents may show different faces

Consequently a crystal very pure in appearance transparent, and without inclusions may contain foreign matter, and in the case where it is the mother liquid which is absorbed its purification is impossible The solvent must be changed.

When the crystals of a determined substance obtained from two different solutions do not present the same forms it is incontrovertible that in one of the cases, perhaps in both cases since we do not always know the *form* of the pure crystal there has been absorption of the molecules of the mother liquor Sometimes it is the water which is absorbed and this water has been regarded as water of crystallization or as water of constitution according to the temperature at which it is driven off

When purification is attempted by recrystallization if the foreign substance which passes into the crystal is present in small quantities in the mother liquid the first or the last crystals formed according to the mode of synchronous crystallization will be the purest In case there is a division of the foreign matter between the crystal and the liquid if the coefficient of its solubility in the crystal and the liquid are known the number of crystallizations demanded for the purification of the crystals may be calculated under proper conditions

V

The natural crystals appear in such varied habits that before Romé de l Isle no one could see the constancy of forms and the genius of Hauy was necessary to establish their derivation It is known that ordinarily the crystals of the same deposit and the same generation are identical and that those of successive deposits or generations may have different dominant forms All these differences may be explained by the rapidity of crystallization but especially by the constant presence of foreign substances Unfortunately it is difficult to determine the nature of the latter since the results of analyses made up to the present time have little value in solving this problem Indeed a very small quantity of matter is required to modify the forms of a crystal sometimes an amount even less than one one thousandth of the weight of the latter is sufficient

In every case whether we have to do with natural or artificial crystals we need to determine their form in the pure state a forn which is constant and which I have called fundamental It may be distinct from the primitive form chosen by crystallographers

In closing I shall observe that the substances prepared in laboratories seem rarely to show the numerous modifications of *form* so frequent in the natural crystals This is due to the fact that the artificial crystals are prepared almost always in the same manner with the same reagents and consequently with the same foreign substances in the mother liquor In nature on the contrary as the analyses of mineral waters show the composition of the solutions which deposit the crystals of a given substance varies from one region to another as much in the quality as in the quantity of the different elements dissolved But all crystals do n t lend themselves with the same facility to these modifications of the faces and just as there exist in nature b lies like alcite which possess the most varied habits there exist also artificial compounds the crystals of which may appear in a great number of forms depending on the condition of crystallization as for example phthalic acid meconic acid nitrate and oxalate of urea

[1] To show this, it is enough to take a colored liq id b t with the exception of bromide there is no liquid which has a proper color at the ordinary temperature

Lord Morley on Science and Literature

Association with Science as a Literary Asset—The Literary Shortcomings of Scientific Men

AN eloquent address on language and litera ure was delivered on January 27th by Lord Morley of Blackburn as president of the English Association Parts of the address dealt with the relation between science and letters with particular reference to the use of scientific knowledge in poetry and the antithesis between documentary fact and artistic style Science aims at concise and truthful expression and while Lord Morley testified to the value of its influence upon literature he doubted whether scientific ideas had inspired even Tennyson to the best verse whether the desire for fact scientifically recorded is not a misfortune in the treatment of modern history and whether concentration upon scientific truth has not a deadening effect upon emotional conceptions and pleasures

In commenting on the address *Nature* remarks Lord Morley s tribute to some scientific master f clear and simple exposition resigns s to his subsequent conclusions Keats could not forgive optics for robbing the rainbow of its wonder and mystery and Lord Mo ley seems to suggest that the literary art which deals with scientific studies and results is not of the highest But poetry is imagery and new images of Nature are made possible by every discovery of the attributes and meaning of the things around us The poetry which neglects advances of natural knowledge becomes conventional in form and substance concerning itself only with the wonders of childhood because it does not understand the higher and grander mysteries which science has failed to penetrate History is concerned with the accumulation and consideration of facts with the view of arriving at correct conclusions from them and in this respect it must be studied by the methods of science though the human factor makes the problems more difficult than when material things only are involved There is however no intrinsic reason why Gibbon s majesty of historic conceptions and the symmetric grandeur of his design should not be combined with such great learning as was displayed by Lord Acton Accurate knowledge must surely not be considered as antithetic to perfection of style

"The instance of Darwin s loss of interest in poetry and music proves little A wide search through the biographies of distinguished men of science will only reveal two or three cases in which devotion to studies of Nature has resulted in the atrophy of æsthetic faculties. Close concentration upon any particular subject often leads to indifference to the aims and work of others but this is as true of art, or poetry or music as it is of science There is less reason for believing that the man of science has usually no taste for literature music or other forms of refined and imaginative expression, than there is for concluding that artists, musicians, and poets have no interest in the attentive study of natural objects and phenomena. If science and documentary evidence are responsible for an age of prose, it is because the poets have been spinning cobwebs from their brains when they ought to have been learning something of the spirit and achievements of science These are they who having never entered upon scientific pursuits are to use Herbert Spencer s words blind to most of the poetry by which they are surrounded

Subjoined are some extracts

Let me offer a few words on the effects of the relations of letters and science We may obviously date a new time *from* 1859 when Darwin s *Origin* of Species appeared and along with two or three other imposing works of that date launched into common currency a new vocabulary We now apply in every sphere high and low trivial or momentous talk about evolution nat ral selection environment heredity survival of the fittest and all the rest The most resolute and trenchant of Darwinians has warned us that new truths begin as rank heresies and end as superstitions and if he were alive to see today all the effects of his victory on daily speech perhaps he would not withdraw his words That great controversy has died down or at least takes new shape leaving after all is said one of the master contributions to knowledge of nature and its laws and to man s view of life and the working of his destinies

Scientific interest has now shifted into new areas of discovery invention and speculation Still the spirit of the time remains the spirit of science and fact and ordered knowledge What has been the effect of knowledge upon form or lang age on literary art? It adds boundless gifts to human conveniences Does it make an inspiring publi for the master of either prose or verse? Darwin himself made no pretensions in authorship He once said to Sir Charles Lyell that a naturalist s life would be a happy one if he had only to observe and never to write Yet he is a writer of excellent form for simple and direct description patient accumulation of persuasive arguments and a noble and transparent candor in stating what makes against him which if not what is called style is better for the reader than the finest style can be One eminent literary critic of my acquaintance finds his little volume on earthworms a most fascinating book even as literature Then although the controversial exigencies of his day affected him with a relish for laying too lustily about him with his powerful flail I know no more lucid effective and manful English than you will find in Huxley What more delightful book of travel than the 'Himalaya Journals of the great naturalist Hooker who carried on his botanical explorations some sixty years ago and happily is still among us?

Buffon as man of science is now I assume little more than a shadow of a name and probably even the most highly educated of us know little more about him than his famous pregnant saying that the style is the man—a saying by the way which really meant no more than that while nature gave the material for narrative it is man who gives the style Yet the French to this day count him among the greatest of their writers for order, unity precision, method clearness in scientific exposition of animated nature along with majestic gifts of natural eloquence. Then com s the grea st f all Whatever the decision may be as to the value of Goethe s sc e itific contribution his at leas is certain that his is the most won dro s the n j e ase of a man who united high original s ient fic power of mind with ranscendent gifts in flight force and beauty of poetic imagination

As for s ience and the poets or ly the other day an attractive little book published by Sir Norman Lockyer shows how Tennyson the co poser of verse unsurpassed for exquisite music in o r English tongue yet followed with unflagging interest the problems of evolution and all that hangs upon them Whether astronomy or geology—terrib e muses as he well might call them—inspired the better elements of his beautiful work we may doubt An English critic has had the courage to say that there is an insoluble element of prose in Dante and Tennyson has hardly shown that the scientific ideas of an age are soluble in musical words Browning his companion poet nearly unive sal in his range was too essentially dramatic t o independent of the scientific influences of his day too careless of expression to be a case much in p int Tennyson said of him he had power of intellect enough for all of them but he has not the glory of words Whether he had or not science was not responsible.

I should like to name in passing the English poet who in Lowell s words has written less and pleased more than any other Gray was an incessant and a serious s dent in learned tongues and his annotations on the System of Nature by Linnæus his contemporary bear witness to his industry and minute observation as nat ralist.

In prose fiction was one writer of commanding mind saturated with the spirit of s ience Who does not feel how George Eliot s reative and literary art was impaired and at last worse than impaired by her daily associations with science? Or would it be truer to say—I often thought it would—that the decline was due to her own ever-deepening sense of the pain of the world and the tragedy of sentient being?

Let us look at the invasion of another province by the spirit of the time The eager curiosity of all these years about the facts of biology chemistry physics and their laws has inevitably quickened the spread both of the same curiosity and the same respect quickened by German example for ascertained facts into the province of history Is the p re scientific impulse—to tell the exact truth with all the necessary reservations—easy to combine with regard for artistic pleasure?

The English writer of our own immediate time with the fullest knowledge and deepest understanding of the fact and spirit of history would I think be pronounced by most critics with a right to judge to be the late Lord Acton Acton s was a leading case where knowledge and profundity was not matched by form His page is overloaded he is often over-subtle he has the fault—or shall I call it the literary crime? —of allusiveness and indirect reference—he is apt to put to his reader a riddle or a poser and then to leave

him in the lurch Here is Acton's own account of the historian's direct debt to the methods of science

If men of science owe anything to us he says, we may learn much from them that is essential For they can show how to test proof how to secure fullness and soundness in induction how to restrain and employ with safety hypothesis and analogy It is they who hold the secret of the mysterious property of the mind by which error ministers to truth, and truth irrecoverably prevails"

Where the themes and issues are those of scientific truth that prose should be unemotional is natural Everybody knows Darwin's own account, how as the laborious years passed he so lost his taste for poetry that he could not endure to read a word of it, Shakespeare became so dull it nauseated him, and music set him thinking too energetically on what he had been working at, instead of giving him pleasure. If all this loss was the price of years of fruitful concentration in the matter, who can wonder if the scientific and documentary age is an age of prose?

The Air-brake as Related to Progress in Locomotion—II*

The History of a Great Invention

By Walter V Turner Chief Engineer, Westinghouse Air Brake Co, Philadelphia, Pa

Continued from Supplement No 1840, page 214

RECENT DEVELOPMENTS IN TRAIN BRAKE APPARATUS

The typical brake equipments which have been mentioned namely Straight air plain automatic quick action automatic and the high speed brake mark epochs during which the respective equipments were each able to successfully meet the traffic requirements existing for the greater part of the periods during which they were supreme but as the demands of service became steadily more severe each in turn gave way to its successor the improved equipment in each case being in its turn satisfactory for such a time as the conditions which brought it into being were not greatly changed

This growth it will be noted was along lines of improving the degree of efficiency of the fundamental functions of the original plain triple valve either by increasing the air pressure carried for braking purposes or by the aid of additions to the valve structure itself or by the attachment of additional devices to existing apparatus or by combination of two or more of the expedients just mentioned

With the high speed brake the practical limit to improvement along such lines was believed to have been reached For some time little or no improvement was thought possible and this was indeed a fact so far as further progress along lines previously followed was concerned for two reasons (1) About all was then being obtained from the old type of brake

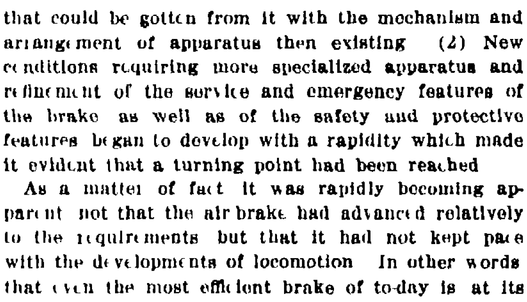


Fig 11 - AMERICAN TYPE OF LOCOMOTIVE 1879

that could be gotten from it with the mechanism and arrangement of apparatus then existing (2) New conditions requiring more specialized apparatus and refinement of the service and emergency features of the brake as well as of the safety and protective features began to develop with a rapidity which made it evident that a turning point had been reached

As a matter of fact it was rapidly becoming apparent not that the air brake had advanced relatively to the requirements but that it had not kept pace with the developments of locomotion In other words that even the most efficient brake of to-day is at its best not able to control and stop a train in the same distance as when the weight and length of the train was less than one-fourth of that to-day That we have done as well as we have will be appreciated when it is considered that the length of the trains and the volume of air employed have rendered this vastly more difficult as to service control and the weight

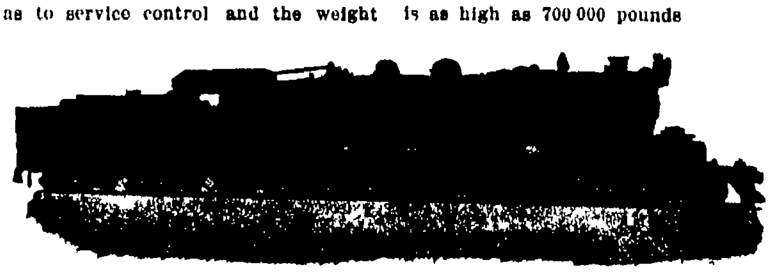


Fig 12 - MALLET ARTICULATED LOCOMOTIVE—ATCHISON TOPEKA & SANTA FE RAILWAY 1909

(which involves many factors) to the extent that it would require at least twice the distance in which to stop if the old brake had to be used with present-day conditions

In addition to the increased weight and speed of trains there were of course increased number of parallel tracks and frequency of trains These always bring with them braking problems quite as difficult of solution and as necessary to be solved as those which preceded them particularly as the tendency is to neutralize or lower the value of many of the

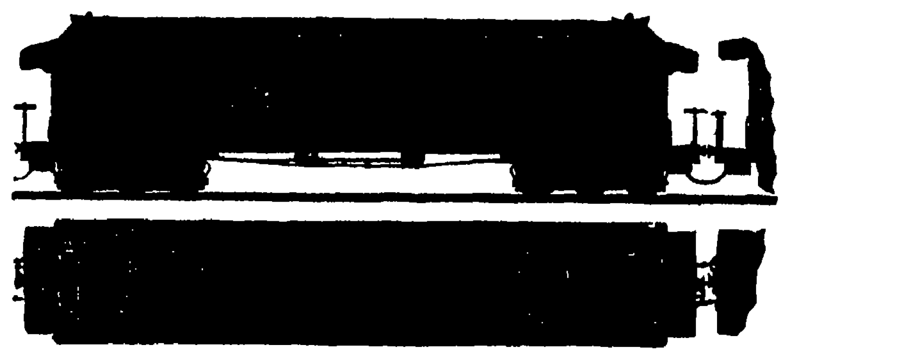


Fig 13—P R R PASSENGER CAR 1872

factors involved in producing and realizing retarding forces

It is difficult for one who has not given the subject careful thought to realize the great changes in railroad equipment and operative requirements which have taken place since the introduction of the air brake but it is only necessary to review briefly these past and present conditions in order to appreciate the necessity for a similar development and improvement of the apparatus used for controlling trains under these new conditions

The following comparative tabulations comparing the conditions existing from 15 to 20 years ago and those of to-day with regard to extent of territory covered capital involved traffic handled and so on will perhaps illustrate the conditions that now have to be faced better than the mere statements which have just been made

Railroad Development From 1889 to 1909

	1889	1909	Increase Per Cent
Miles of line	153 385	234 182	52
Miles of track	136 958	340 000	8 5
Net capital	$ 850 745 000	$13 508 11 000	63 3
Passengers carried	4 2 1 1 000	890 04 000	86 5
Tons freight carried	539 639 000	1 486 000 000	1 5 8
Locomotives number	29 036	5 220	197 0
Freight cars number	829 886	2 113 150	154 6
Employees number	04 43	1 754 000	110 2
Employees compensation	$480 785 504	$1 003,270 000	107 4
Electric railway		50 000	

Locomotives—The weight on drivers has increased since the air brake was invented from 25 000 pounds to 400 000 pounds

The drawbar pull of locomotive has increased since the air brake was invented from 10 000 pounds to 100 000 pounds

The total weight of locomotives at the present time is as high as 700 000 pounds

Working steam pressure has increased since the air brake was invented from 125 pounds to 225 pounds.

Passenger Cars—Weights have increased from 20 000 pounds to 150 000 pounds

Freight Cars—Light weight of car has increased from 12 000 pounds to 50,000 pounds

Capacity has increased in the last twenty years from 40 000 pounds to 150,000 pounds

Passenger Trains—Schedule speeds have increased from 30 miles per hour to 65 miles per hour

The energy contained in a five-car train of cars having an average light weight of 80 000 pounds per car running at a speed of 35 miles per hour, is 6 200,000 foot pounds of cars having average weight of 127 000 pounds running at 65 miles per hour it is 90 000,000 foot pounds or nearly fifteen times as much

Freight Trains—Train length has increased from 15 to 130 cars total weight has increased from 300 to 4 500 tons and in certain places in the country as high as 6 000 tons

To take an actual example illustrating what is involved in the handling of a modern high-speed passenger train the following figures are taken from the official report of the Emergency Brake Tests carried on about a year ago by the Lake Shore & Michigan Southern Railway near Toledo

Lake Shore Emergency Brake Test.

	Weights	
Types of vehicles used	Pounds	Tons.
Locomotive—Pacific type	388 000	194 0
Buffet car	149 000	74 5
Dining car	140 000	70 0
Sleeping car average	125 000	62 5

Energy in Test Trains

Make up of train	2 Loco —10 Cars	1 Loco —6 Cars
Train weight—pounds	2 068 000	1 180 000
Train weight—tons	1 034	590
Energy at 40 M P H foot pounds	116 816 000	66 595 200
Energy at 40 M P H foot tons	58 408	33 298
Energy at 60 M P H foot pounds	262 836 000	149 839 200
Energy at 60 M P H foot tons	131 418	74 920
Energy at 80 M P H foot pounds	467,264 000	266 380 800
Energy at 80 M P H foot tons	233 632	133 190

Kinetic Energy* in Train of 2 Locomotives, 10 Cars of 75 Tons Weight Each—Total Train Weight, 2 276 000 pounds, or 1,138 Tons.

Speed	40 M P H	60 M P H.	80 M P H
Foot pounds	127,811 200	287 575,200	511,244 800
Foot tons	63,906	143 787	255,622

Figs. 11 and 12 present a tangible evidence illustrative of both extremes of the locomotive development indicated in the tabulations just given The view of the American type of locomotive (Fig 11) representing standard practice of 1879 can no doubt be recalled by many and is in marked contrast with the enormous Mallet Compound Locomotives (Fig. 12) now being introduced for heavy grade service in various parts of the country

Similarly the progress in passenger car construction is graphically illustrated by comparing the typical passenger car of 1872 (Fig 13) with the modern all-

* Presented at the meeting of the Mechanical and Engineering Section

*Kinetic energy in train of 2 locomotives, 10 cars of 75 tons weight each—at speed of 80 M P H is sufficient to raise 1 ton to a height of over 48 miles.

steel Pullman cars (Fig 14), which are being built at the present day

All the figures which have been given report the maximum conditions of past and present-day practice As the application of the air brake has made this enormous increase in weight of vehicles speeds and length of trains possible it is fair to assume that the stopping power of the brake should logically be increased in the same proportion so that the stop should be no longer now than formerly

A concrete example will show forcibly just what this increase in weight and speed means to the operating department if it is to accomplish such an admittedly desirable and necessary result Under the former conditions the factor of safety in train handling was none too large and it is therefore imperative that we should be able to control modern trains under present existing conditions at least as safely and efficiently as formerly To do this for five 150 000-pound coaches running at 65 miles per hour it is necessary to provide means for controlling over 105 000 000 foot pounds of energy as compared with about 6 000 000 foot pounds which was all that the brake of the early 70 s was called upon to control with a train of five 30 000 pound cars running at 35 miles per hour When the locomotive used with each train is considered the total energy in the modern train becomes 162 000 000 foot-pounds as compared with 9 800 000 foot pounds for the train of 1870 It is not surprising therefore that the air brake art demands thoughtful consideration from trained and experienced minds if the railroad traffic of to-day is to be handled with a safety and efficiency even equal to that of the days when the total energy to be reckoned with was one sixteenth as great Here again is found another close resemblance between the conditions of acceleration and deceleration for while it is not especially difficult to increase the speed of a train from 30 miles per hour to 40 miles per hour it requires the expenditure of a vastly greater amount of energy to increase its speed from 60 miles per hour to 70 miles per hour In like manner for any given increase in speed the additional amount of work required from the brake increases in geometrical not arithmetical ratio If therefore the improvements for the heavier trains and higher speeds of to-day permit of stopping in about the same distance as could be done with the brake of forty years ago and the trains of that period we should congratulate ourselves for having held our own

The mere power necessary to accomplish this is indicated by the fact that the total maximum force exerted by the push rod of the 6 inch brake cylinder of the early equipment was 1 700 pounds while with the 18 inch brake cylinder used on the heaviest coaches a maximum pressure on the push rod of 26 670 pounds is obtainable

From the foregoing it will be apparent that many features must now be considered which did not exist when the brake was first invented particularly on the physical side of the problem For example the amount of work required per square inch of brake shoe surface is vastly greater This is a condition seldom noticed and yet of great significance, as the following comparison will show

In the report of one of the earliest brake trials in the history of continuous brakes, made on the Midland Railway, near Newark, England, in 1875, and since known as the Newark trials (see London *Engineering* June and July, 1875) the best brake performance recorded was by a train of fifteen 21 000 pound (average) four wheel carriages fitted with a primitive form of the Westinghouse automatic brake one cast iron brake-shoe being used on each wheel The best stop was made from a speed of 52 miles per hour the highest that could be obtained in 18 seconds This corresponds to the performance of 15 5 foot tons (1 ton = 2 000 pounds) of work per brake shoe per second In the classic Westinghouse-Galton tests which followed about three years later the four wheel experimental van used weighed 18 200 pounds and was fitted with two brake shoes per wheel and from 52 miles per hour speed a stop was made by the experimental van alone in 11½ seconds Here the work done was only about 9 foot tons per brake shoe per second

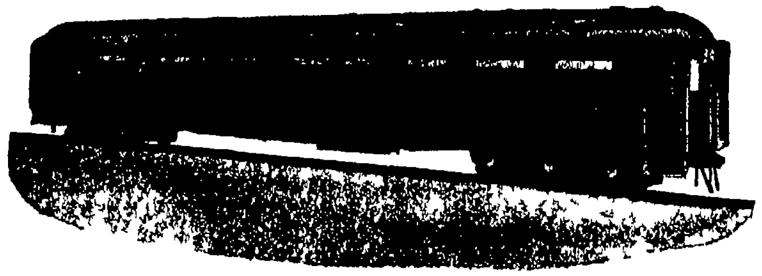


Fig 14—ALL-STEEL SLEEPING CAR 1909

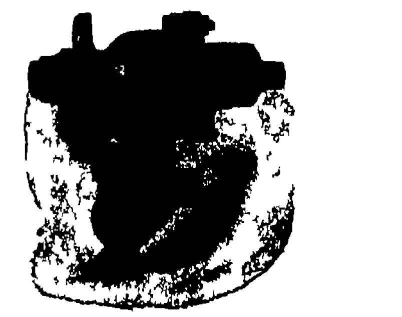


Fig 16—TYPE K FREIGHT TRIPLE VALVE

In 1875 the standard passenger coach used on the Pennsylvania Railroad weighed 39 300 pounds and had four wheel trucks To stop such a car from 52 miles per hour in 18 seconds required only 12 33 foot tons of work per brake shoe per second or less than that required of the brake on the Midland train although the Pennsylvania car weighed 18 300 pounds more This is of course due to the fact that eight brake shoes were available to do the work as compared with four on the Midland train Contrast with the above a modern Pullman car weighing 160 000 pounds and having six wheel trucks Assuming that from a speed of 52 miles per hour that stop could be made in 18 seconds the work done would be 33 5 foot tons per brake-shoe per second or over twice that of the Midland train notwithstanding that there are twelve brake-shoes to do the work instead of four But modern express train speed may be expected to run frequently as high as 75 miles per hour and to make a stop from this speed in say 35 seconds (which would be about the best that could be expected of the modern brake equipment) would require 35 8 foot tons per brake-shoe per second or not much more than when a stop of 52 miles per hour is made in 18 seconds But to have the same absolute safety under modern conditions as existed in 1875 would require the stop to be made in at least the same distance and time and to stop a 160 000 pound car from a speed of 75 miles per hour in 18 seconds would require 69 6 foot tons of work per brake shoe per second or about 4½ times that in the case of the Midland train (What this would be with four wheeled trucks will be appreciated) Even if two brake-shoes per wheel could be used instead of one there would still be over twice as much work to be performed by each brake shoe per second if the trains of to-day at the speeds now attained in high speed service are to be relatively as safe as the trains of thirty years ago Furthermore the use of two brake shoes per wheel is rapidly becoming a necessity not only on account of the great amount of work to be performed by each brake shoe but also because the brake shoe pressure required by modern conditions of high speeds and heavy cars are becoming so great that in emergency applications a heavier pressure is brought to bear on the axle and journals by the brake shoe acting on one side of the wheel only than is imposed by the weight of the car resting on that wheel

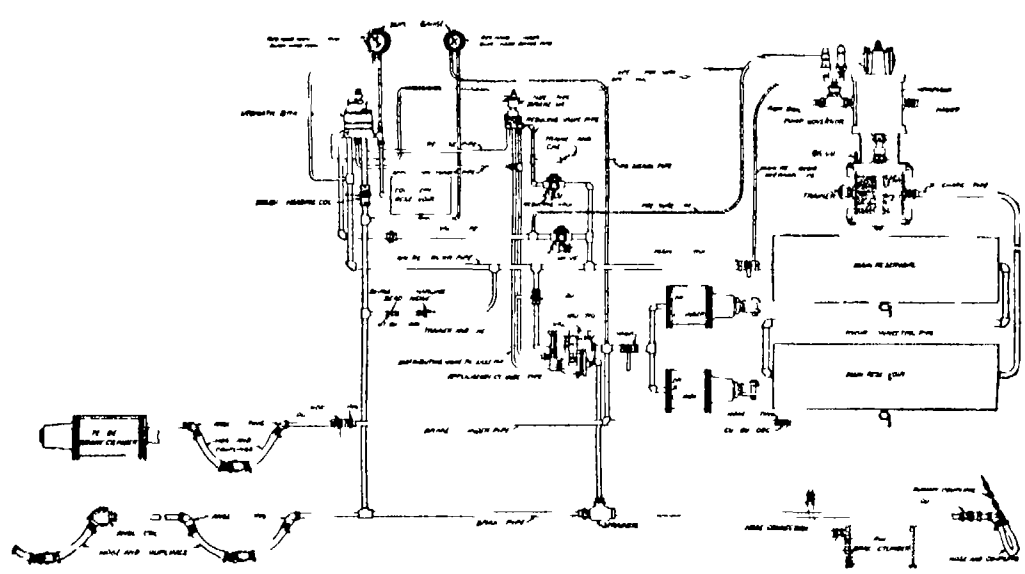


Fig 17 PIPING DIAGRAM ET EQUIPMENT

The tremendous significance of this increase is but faintly appreciated by those who have not had occasion to investigate this aspect of the question The cast iron brake shoe is to day practically as it was thirty years ago This brake shoe must now do four times the amount of work by frictional resistance to the rotation of the wheel as formerly It may be suggested Why not quadruple the pressure per brake shoe But it also must be remembered that when the brake shoe pressure is multiplied by four the actual retarding force is by no means quadrupled for three vital adverse factors are being overlooked viz the effect of increased pressure speed and temperature on the coefficient of friction between the wheel and the shoe Exactly how great an effect these may have depends of course on the conditions of the individual test considered but that it is considerable is proven by the fact that a stop from a speed of 75 miles per hour in 35 to 40 second instead of 18 seconds is considered good although we are to day using about four and a half times as much pressure per brake shoe as at the Newark trials

It should be stated that in the above no account is taken of the rotative energy of the wheels If this is considered it is evident that the figure for the modern conditions will be still more in excess of those of the past on account of the wheels being heavier and there being a greater number per vehicle

Again the difference in air pressure required to apply and release the brakes is by no means as easily obtained to day as when trains were short The air supply required for short trains with small brake cylinders was obtained with compressors of much less

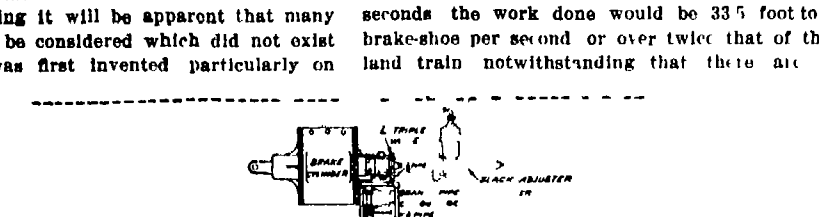


Fig 15—IMPROVED PASSENGER BRAKE EQUIPMENT TYPE LN

capacity than is now necessary to employ, witness, the 6-inch air compressor of the early days of the brake with its capacity of not over 15 cubic feet per minute as compared with the cross compound com pressors now used which have approximately 125 cubic feet capacity The reason for this is apparent, for it required not so very long ago about 25 to 30 cubic feet for a full application now 300 cubic feet is required

In general therefore it may be stated that the brake which would satisfactorily meet the requirements of past conditions falls short of the maximum efficiency which it should be possible to attain in proportion to the increase of the requirements of present day service over those of the past The force of this is apparent when the same comparison is made between the locomotives and cars of the two periods. This review of the conditions and what is involved which is by no means exhaustive will serve to give an idea of the magnitude of the problem How the various stages of this problem have been solved as *they presented themselves* will be shown best by a consideration of the features and functions of the im proved brake apparatus that was developed to meet the conditions just explained

CHARACTERISTICS OF IMPROVED BRAKE EQUIPMENTS

While the fundamental service and emergency fea tures of the quick action brake could not be departed from on account of the necessity for maintaining inter changeability of apparatus and operative function it was clear that in designing a brake to meet these new conditions not only must the fundamental features of the old brake be improved to their highest possible efficiency but new features must be added some of which were inherently impossible if the design were carried on along the lines previously laid down

With this as a point of departure, the develop ment of the newer forms of locomotive passenger and freight brakes was commenced and it may be fairly said that with the incorporation of the new features which will be explained in what follows the air brake entered upon a new era of its history as distinct from that which preceded covering the progress of the art from the development of the plain automatic brake to the high speed brake as that era was distinct from those of the straight air brake and of the hand brake which marked the earlier history of the art

Briefly stated the recognition of the new principles required by the changed conditions referred to led in the case of the passenger brake to the incorpora tion of the following features in addition to those char acteristic of the previous form of equipment (See Fig 15)

1 Quick rise of brake-cylinder pressure so that the braking power may reach its maximum in the short est possible time and thus begin to be effective in reducing the speed when at its highest value—and when the increase in distance run before coming to a stop is greatest for every second's delay

2 Uniform braking power on all cars irrespective of size of equipment and variation in piston travel thus contributing largely to the convenience and com fort of passengers as well as making the brake more reliable and therefore easier to manipulate

3 Maintenance of both service and emergency brake cylinder pressures up to the capacity of the ample storage reservoirs of the cars This is of the greatest advantage in overcoming the ever present and often serious depletion of brake-cylinder pressure by packing leather leakage

4 Predetermined and fixed limiting of maximum service braking power without a safety valve or other blow-off device This maintains the proper margin be tween the power of service and emergency applica tions and tends to reduce wheel sliding without wast ing air and with a minimum of apparatus thus result ing in economy both of operation and maintenance

5 Quick service feature to compensate for in creased length of train and bring about more prompt, uniform and certain application of brakes

6 Quick recharge of the auxiliary reservoirs to offset longer trains and larger cylinders and reser voirs and insure a prompt application of the brakes when desired and prevent the depletion of the auxil iary reservoir pressure

7 Graduated release feature to add to the flexi bility of the brake by making it possible to graduate the brakes off as well as on and so to handle the train more smoothly with a greater saving of time and a reduction in the amount of wheel sliding

8 Much higher brake-cylinder pressure obtained in emergency for the same brake-pipe pressure carried which pressure is maintained and retained during the complete stop thus materially shortening the stops and adding greatly to the safety of the trains

9 Automatic emergency application on depletion of brake-pipe pressure This is a safety and protective feature of great value in that it insures sufficient braking power being automatically obtained to bring the train to a stop in case the system is depleted be low a predetermined pressure either by careless ma nipulation or accidentally

10 Full emergency braking power at any time, thus placing the maximum stopping power the brake has to offer at all times ready for use by the engineer whenever an emergency arises, irrespective of what may have preceded

11 Separation of service and emergency features so that the necessary flexibility for service applications can be obtained without impairing in the slightest the emergency features of the equipment and conversely so that undesired quick action is practically impos sible.

12 High maximum braking power secured with low total leverage, with correspondingly greater over all efficiency of the brake

13 Better mechanical design resulting in more uni form wear of parts and ease of access for removal or repairs

In the case of the freight brake, the change in the conditions which require a change in apparatus were in the direction of greatly increased length of trains, and difference between the light and loaded weights of the cars The features of the new freight brake were therefore developed with particular reference to those considerations as follows (See Fig 16)

1 Ability to apply and release the brakes without fear of shocks under conditions where they are cer tain with the old brake, gives an added value to all rolling stock

2 As only a comparatively light reduction is re quired with the quick service valves to apply all the brakes and with uniform cylinder pressure there is not sufficient braking power developed in any one part of the train to cause the slack to run in or out severely On the other hand with the old brake, a heavy reduction is required to apply the brake at the rear of a long train the effect of which is to bunch the slack severely with consequent running out again as the brakes take hold at the rear and the draft springs recoil As shock is the complement of time and the place where the retarding force is developed it will be seen that shocks, due to brake applications will be greatly reduced with the new valve for while the time required to dissipate the energy of the mov ing train will be the same the distribution of the braking power will be different as it will be divided among all the vehicles in the train instead of first at one end and then at the other

3 Because more applications and release can be made in the same time with the new brake than with the old—much better control and safer operation of the long trains are obtained

4 On account of the uniform release feature and because a maximum or full service application of the brake is seldom required with the new brake, the re lease is more prompt and certain at the rear (which as has been shown is the vital place of a long train) and the number of stuck brakes' flat wheels, and shocks are greatly reduced particularly as no damage can be caused by the engineer opening the throttle before the brakes at the rear have released

5 The uniform recharge feature assists in this, in asmuch as the number of stuck brakes (resulting from a re-application due to over-charging after a re lease) is reduced and more equal response of all the brakes secured for subsequent application.

6 The quick service feature makes possible much shorter stops which is important at all times, but par ticularly where block signals are in use This makes unnecessary quick action applications of the brake ex cept in cases of actual danger

7 The uniform release feature in grade work to a large degree acts as an automatic retaining valve, which is one of the factors in the increased control

8 The uniformity of application and release tends to reduce the serious effects of the wide difference of braking power with loaded and empty cars in the same train

9 That vital factor in train control the personal equation is made more uniform, as less skill and judgment is required to get good results while lack of these cannot result in so much harm

10 As the air required to obtain the same control is only one-third of that required by the old brake, there is much less danger of the supply being inade quate and with brakes in a reasonably operative con dition there is more likelihood of the engineer stall ing or stopping than of "losing his air

11 Much shifting of lading and breaking-in-two now caused independent of the brake, by stopping and starting will be eliminated as slow downs instead of stops can be made

12 More tonnage can be handled and at higher and more uniform speeds, with safety than has heretofore been possible.

13 Accidents, due to broken wheels, will be fewer, as with the new valve each brake does nearer its share of the work; thus, the excessive heating due to hand brakes being used, or a few brakes doing the work, no longer takes place.

14 (*a*) The old valves are greatly helped by the new ones when mixed in a train (*b*) The new fea tures are simply additions to the old valves, the funda mental operative functions and principles remaining the same as in previous forms.

15 With the empty and load brake, greatly in creased tonnage can be handled with equal or even more safety, and for mixed empties and loads in the same train the elimination of damaging stresses due to inequality of braking power on empty and loaded cars. The characteristics of this equipment and its peculiar advantages merit a more extended descrip tion which will follow a little further on

In the case of the locomotive brake the new fea tures characteristic of the improved equipment were naturally in part due to the necessity for bringing the locomotive equipment up to an equal efficiency with the improved passenger and freight brake apparatus as just outlined

In addition, however certain desirable operative fea tures had long been recognized but remained imprac ticable until the establishment of a new basis for de sign afforded an opportunity for including in a com pact and mechanically satisfactory combination of parts all that previous experience had shown to be desirable in an efficient locomotive brake (see Fig 17) Briefly stated these are as follows

1 Either entirely independent or simultaneous operation of the train and locomotive brakes as may be desired thus permitting of much greater degree of convenience and flexibility in handling long trains es pecially on grades, in switching etc

2 Maintenance of brake-cylinder pressure whether partial or full application up to the capacity of the compressor thus insuring that the desired amount of braking power on the engine will be obtained and maintained irrespective of the leakage which is so difficult to prevent in the case of locomotive brake cylinders especially

3 Uniform brake-cylinder pressure in all brake cylinders on the locomotive irrespective of piston travel number of cylinders or leakage thus doing away with the necessity for different size or type of operating mechanism for different sizes of cylinders or types of locomotives as well as insuring against variations in braking power due to differences in pis ton travel, which must always be reckoned with on account of the brake-shoe wear or neglect in adjust ment.

4 Predetermined and desirable increase in emer gency brake-cylinder pressure over the maximum ob tainable in service thus securing for the locomotive brake equipment an advantage long recognized as fundamental for all car brake equipments

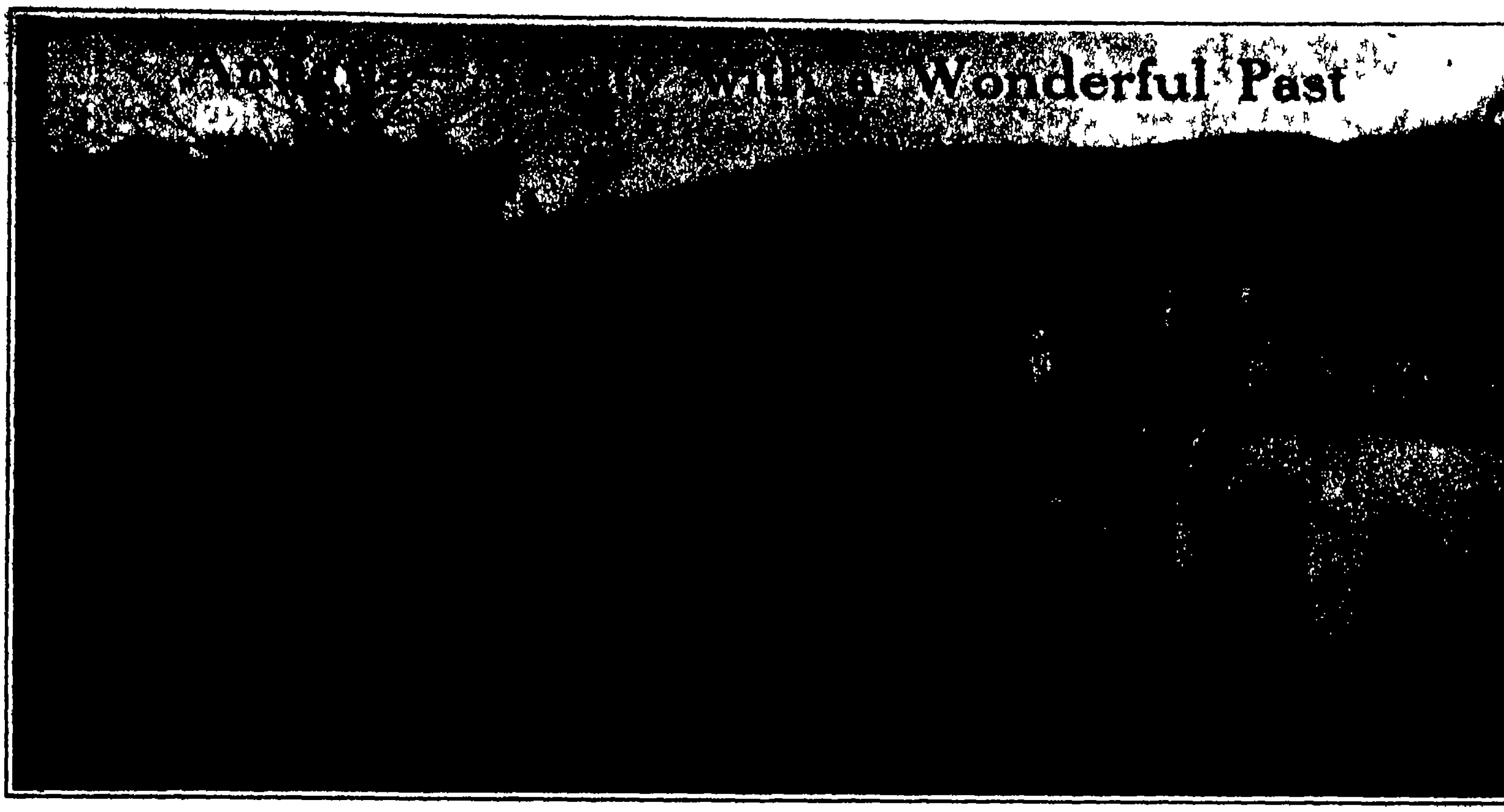
5 Automatic protection against loss of air required for braking due to brake-valve handle being left in lap position by mistake

6 Graduated release feature for the locomotive brakes which will then work in harmony with the new graduated release type of passenger car brake

That the above features are all in the direction of increased convenience economy and safety in the handling of both passenger and freight traffic, is self evident, but when it is further considered that these advantageous improvements have been incorporated in a combination of apparatus less complicated and with fewer number of parts than required by the old equip ment at its best and that the mechanical design and arrangement of parts has been greatly improved with respect to minimizing the wear due to ordinary service and in increased ease of maintenance and repairs it will be seen that the character and degree of the im provements which have been made are in accord with, and not antagonistic to the demands of modern rail road service for apparatus of the highest efficiency coupled with a maximum of economy and a minimum of complexity

(To be concluded)

A new instrument for measuring nocturnal terres trial radiation invented by the late Knut Angström is described by his son, A. K. Angström, Jr, in *Annalen der Physik*, under the name of "condensation-actinometer" Excepting an external cylinder of metal the instrument is made entirely of glass. It consists of a reservoir, exhausted of air, and contain ing ether, into which projects a glass chamber open above to the air and coated with lampblack. The blackened surface radiates heat more rapidly than the rest of the apparatus, and tends to lower the temperature within the reservoir, this cooling is, however, compensated by the condensation of ether, which distills over into a graduated glass tube. The total amount of radiation from the black surface dur ing a given interval is proportional to the amount of ether condensed Its value in thermal units may be obtained by the use of a constant, determined by com paring the instrument with other actinometers.



RUINS OF A CONVENT IN ANTIGUA THE CELLS OF THE NUNS

FOR many years after the signal conquest of the Aztecs by Cortez adventurous gentlemen at arms fired by his success and by the still more potent lure of tales of fabulous riches formed numerous expeditions to penetrate the fastnesses of the New World Pizarro lead his unscrupulous band to plunder the golden land of the Incas Olid conquered Honduras Ponce de Leon searched for the Spring of Eternal Youth Coronada journeyed toward the fabled Seven Cities of Cibola and De Soto endeavored to penetrate the southern wilds to the great Pacific while Cortez himself explored the country from Mexico to what is now Puerto Cortez Honduras but which he named Puerto Caballos from the number of horses lost in landing there

It was however left for Don Pedro Alvarado the most unscrupulous and dashing of his lieutenants to conquer the powerful nations of Quiches Cakchiquels and Mams who dwelt in what is now Guatemala or Quahtemala as the Indians then called it meaning Land covered with trees

About the year 1524 Alvarado led an expedition of one hundred and twenty horsemen one hundred and thirty cross bowmen and one hundred and seventy men-at-arms together with an auxiliary army of nineteen to twenty thousand natives against the allied Quiche forces under the command of Kicab Tenab the Quiche chieftain The often enacted tragedy took place through intrigue false promises ancient tribal animosities and superior armament the native forces were already doomed when the rival armies clashed upon the plains of Quetzaltenango (place of the quetzal the native bird of Guatemala at the present time)

Here under the warm tropical sun the battle waged throughout the day and many were the deeds of valor and desperation performed on both sides Confronted by wonderful weapons in the hands of strange beings mounted on their terrible horses the Indians fought long and well while ever in their front moved the glittering plumes and dripping spear of Tecum the valiant son of Kicab Tenab with his nagual or familiar spirit in the form of a quetzal hovering—according to legend—constantly over his head

Finally the two chieftains of the opposing forces met and all of Alvarado s skill availed him naught against the courage and the nagual of the Indian for as long as the quetzal lived Tecum could not be harmed. At last a Spaniard by the name of Arguete killed the nagual and tradition has it that Tecum then fell dead at Alvarado's feet and the native forces broke and fled The family of Arguete in Spain bears to this day the quetzal upon its coat of arms in memory of that distant encounter upon the plains of Quetzaltenango by which the Spaniard won a new empire and countless thousands lost their birthright, while the Cakchiquels and the Mams were in turn reduced through treachery and the sword

The fate of the Indians was then only too plain—harsh servitude for life under heartless masters They were branded with red hot irons and sold like cattle, one-fifth of the selling price going to the royal treasury of Spain. Alvarado even casually reports burning some Caciques with their towns as he thought In all probability it might have a whole some effect upon the ones left living the effect upon the others being tactfully ignored Stone was quarried and shaped bricks made and wood hewn by the Indians while thousands more of the erstwhile lords of the soil toiled upon the churches and palaces the houses and fortifications of the capital of the newly acquired province of Imperial Spain This with fatal choice Alvarado had located upon the lower slopes of the great volcano of Hunapu in the beautiful valley of the Almoconga high upon the central plateau Little was feared from this grim guardian of the town which reared its head over twelve thousand feet into the clear blue skies as it had long been quiescent and a great lake of water had formed in its crater while two other still higher peaks nearby frowned down upon the misdeeds of the conquerors

So the new capital grew in wealth and importance slumbering in fancied security in the shadow of the great volcanoes while Don Pedro Alvarado having worked long and ardently for the devil in the name of the Lord was made Adelantado Governor and Captain General of all Central America in the year 1530 and ruled in state from the newly founded city After various voyages to Peru Spain and in search of the Spice Islands he was finally killed in Mexico by a falling horse and doubtless laid to rest with all the pomp and ceremony due such a great lord of toiling thousands who slaved because nature had endowed them with a belief in the word of their fellow man a fair country and inferior weapons

Yet through it all the Indians well knew that Sicapua, the god who made the mountains and his brother Cabrakan who made them tremble were merely biding their time to crush the invader and avenge the wrongs of their children And so it came to pass that on a certain terrible night September 11th 1541 but one day after Alvarado s widow Beatriz de la Cueva had been named to serve in his stead the voice of the earthquake was heard throughout the land and mid the rending of the falling walls and the shrieks of the doomed sounded the wild rushing of the waters which poured in an avalanche through a great rent in Hunapu s cone upon the fated town sweeping all before it and leaving but a few solitary ruins where once had stood the glittering capital Many hundreds were killed among them the wife of Don Pedro Alvarado

All that is left to-day are a few sad remains consisting largely of the foundations of a spacious palace and a portion of the crumbling walls of what must have been the old cathedral The natives called the houses clustered about these monuments of the past Cuidad Veihe or the Old Town in contradistinction to Antigua or the second capital

Many traditions were connected by the Spaniards with this great catastrophe for men were then as fond of moralizing as they are now and were less satisfied with apparent reasons when supernatural ones could be applied The widow of Don Pedro Alvarado so runs the legend had given herself wholly up to mourning her noble lord whose amiable traits doubtless grew in direct proportion as the years elapsed. So overcome was she by his loss that she never stirred from the house but spent the long days shut out from the sunshine and the flowers in the darkest room of the palace the walls of which were even painted as black as the clothes she and her tirewomen wore No light nor color no bright blossoms were allowed to intrude upon her sorrow so consuming was it that she even lost that comfort and hope to which all are taught to cling when everything else has failed And so the earthquake came and the great lake burst its confinement to overwhelm the devoted town that by its waters might her sin be washed away and mankind warned for all time against permitting his personal sorrows to supplant the teachings of the church

Hence it transpired that the Spaniards moved their capital four miles distant away alike from the unhallowed spot and from the mountain which had been the agent of their doom that once again might this portion of the New World bear the yoke of Spain and yield to the old its golden flood Complete as had been the revenge of the native gods it was but short lived for the new city was built on a far grander scale than the first one by the unceasing toil of the Indians and once more the white walls glittered in the sunlight beneath the blue skies that overhung the great volcanoes The churches—high vaulted and thick walled sprang up by the score and the Inquisition in its darkest form appeared to wring in unspeakable tortures the lives from unknown thousands The natives, though supposed to be immune were frequently conveniently put out of the way by this means that alone has branded the early Spaniard as decidedly the spiritual inferior as he was undoubtedly the moral and in many material ways of the savages whom he conquered Alas that it should remain for civilized" man to slay by torture that others might be forced to sink to his level of religious degradation and that the frail hand of Isabella of Spain should have left to the world such a bloody legacy The conquerors were not only not contented to grind the vanquished under foot to force them to build their towns and work in the mines and fields to naively burn them alive in their dwellings and subject them to the tender mercies of the Inquisition but they further destroyed the wonderful Mayan manuscripts which contained priceless records of the past in much the same manner as the bigot priest Zumuragua in Mexico piled the Aztecan codices mountain high and applied the torch that thus might the works of the devil" be removed by one of his choicest disciples

Yet in spite of the darkness of its crimes of which only an incomplete record has come down to us the low roofed town in its surrounding of tropical verdure waxed rich and powerful its narrow streets were paved with stone and the sidewalks hardly broad enough for two abutted upon the walls of white buff and blue from which projected the iron barred windows to safely guard the dark-eyed senoritas who gazed upon the passing cavaliers Its plazas and avenidas glittered with life when the music sounded on the moonlit nights and the breeze that stirred the palms and ceibas was heavy with the fragrance of orange blossoms Eight great monasteries five convents and three beaterias housed those of the re-

THE RUINS OF SAN [illegible]

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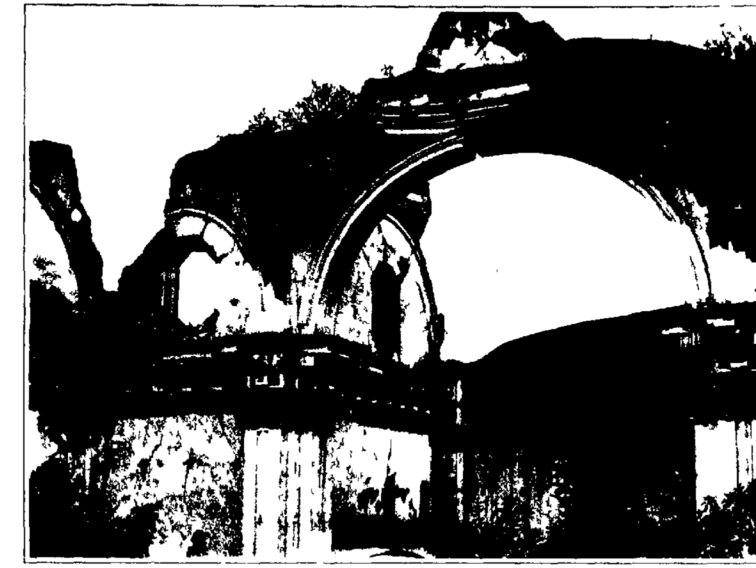
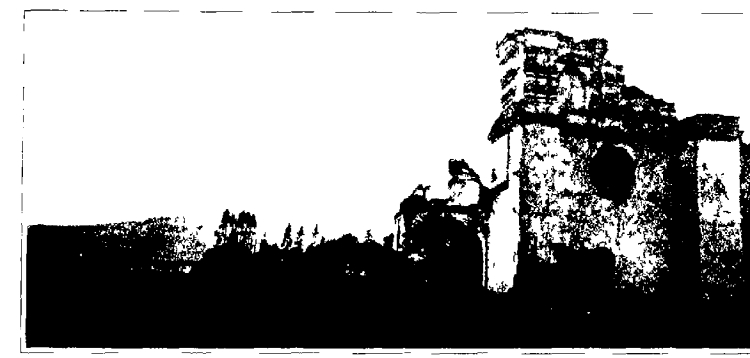
A RUINED CHURCH, VAST, HIGH, ARCHED AND DOMED

RUINS OF LA MERCED



[illegible] VIEW OF THE [illegible] OF THE CHURCH [illegible]



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RUINS OF THE CHURCH [illegible]

ANTIGUA—A CENTRAL AMERICAN CITY WITH A WONDERFUL PAST

ligious orders or whose affiliations were close to Mother Church Two extensive hospitals nursed and comforted the ill in body while three massive jails held securely in their cells and dungeons those whom it was deemed expedient to keep in captivity Yet above all it was Antigua's crowning glory that she boasted over a half a hundred churches within her borders whereby much good seed was scattered broad cast upon the virgin soil

Round about the city like the setting of a diamond clustered seventy picturesque villages each under the charge of a priest and to each of which was assigned the manufacture of some special article In one was found the excellently carved woodwork of which we see specimens to day and for which the native dis plays a singular aptitude in another pottery glazed polished rugose and polychrome while in others iron was fashioned bricks baked or basketry or clothing manufactured For in proud Antigua none of the trades were plied as it was essentially a govern mental religious and social center

Ere the first lights of early dawn had gilded Fuego's brow long lines of merchants could be seen wending their way from the surrounding towns to the great central plaza or open air market there to display their wares to the wakening city and long before sun set the same lines ant like crept toward their homes again

Shaded driveways led through the surrounding country to the fincas and the medicinal baths as even at the present time the valley of the Almocongo is noted for its thermal waters and the rich volcanic ash of its soil

Tribute from the Indians and gold and silver from the mines for many distant leagues poured into its coffers for the suzerainty of Antigua reached from the forests of Yucatan to the gold strewn shores of distant Darien and from the Pacific to the Atlantic Broad paved roads were built from the coast to the interior and many a hidalgo with an eye to the future as well as to the present brought paintings from Spain to grace the stately churches and convents of the proud mistress of all Central America Deep toned bells of bronze cast in the foundries of Toledo or Seville were shipped across the seas to the shores of the New World and then carried up the rivers on barges to later be transported through the forests and over the mountains to their final resting place in the graceful belfries of San Francisco San José and the many other churches that there they might call alike the chosen and the heathen to prayer and save the souls of erring man Yet one bell there was that never reached its destination for after safely passing the dangers of the sea it was lost in the murky waters of the Rio Chamelecon To this day the town near that point is called Campaña which in Spanish means Bell and on certain fiesta nights during the year it is said the solitary wanderer may sometimes hear it slowly ringing beneath the waters

In return for the works of the Old World Antigua sent the heavily ladened galleons with their precious freight to quench the ever quickening thirst of dis tant Spain and so the buccaneers with an equally ab sorbing thirst came that they too might plunder from the plunderer Then the impregnable castle of Amoa was built upon the coast to guard the wealth so in dustriously garnered and it is said that the King of Spain upon once being asked why he stared so in tently through his telescope across the western waters replied I look that I might see Amoa, for truly it has cost enough to make it visible even from here.'

Thus the years rolled by and royal governor suc ceeded royal governor and new eyes looked from behind the window bars where other eyes had peered before at other cavaliers for to all things animate and inanimate there comes a day that must—the end

Long had the gods of the Quiches slumbered and men had forgotten these many years that once they were Yet all this time they had stirred deep down in the heart of the other great volcanoes and sud denly on a never-to-be-forgotten July night in the year 1773 they burst forth again in a mass of flame and smoke upon the sleeping city Deep detonations shook the air and the rumbling of the earthquake once more resounded throughout the land as the out raged gods strode with heavy steps across the trembling earth Belching flames lit the crashing walls and scene of death—churches and palaces, the mansion of the rich and the hovel of the poor lay a crumbling mass Priest and soldier hidalgo and pauper alike were crushed beneath the fallen walls That which the setting sun had viewed the proud mistress of thousands the sunrise found prostrate—but a pile of pitiful ruins The gods of the Quiches once more had triumphed

Yet again among the Spaniards other causes were assigned It was said that there had been dissen tions between the native brothers and the ones from Spain Indeed so bitter had waxed the controversy that the civil authorities were appealed to with the result that certain ones of the Spanish brothers were publicly whipped Therefore it was only a question of hours said the wise before the earthquake came to chasten the wickedness of man Then too there had been scandals connected with the sisters at which men shook their heads—so fortunate indeed is it that professions do not make religion and that its true value is in no way lessened by the acts committed in its name or by those who seek its shelter

Still who can correctly assign a cause for the great ataclysm for did not Antigua gravely aver that a neighboring town had been destroyed because there was no bishop in the place at that time and yet when her own end drew nigh she had no lack of bishops and of priests?

And so it came to pass that the early Spanish capital had been destroyed when the two volcanoes poured forth water and fire and thus it was that the first was solemnly baptised Agu and the latter Fuego and taken with all formality into the church in the hopes that they would reform and eschew their heathen deities and evil ways To this day both Agua and Fuego have faithfully lived up to their re sponsibilities though Santa Maria a number of miles to the north in 1902 blew out her entire side and overwhelmed fincas and cities

Many of the poorer classes even after the second catastrophe clung to their ruined homes and wished to trust to the conversion of the great volcanoes and live where they were born but others there were who had less faith in the intentions of the new converts and others still who owned property upon the site of what is now the City of Guatemala for real estate was cherished in those days even as it is now There-fore it was deemed expedient for many sundry reasons to move the capital twenty-four miles distant to the valley of the Hermita where it now stands. The reluctant ones were dragged forth in spite of un-availing protests, and the remnants of their homes destroyed by the soldiery, that the new city might be-come great and powerful and perchance the values of certain properties be maintained.

So the city of Guatemala has grown at a safer dis-tance from the great peaks of Agua, Fuego and Acatenango completely surrounded by deep barrancas which it was hoped would deaden the earthquake shocks until it again stands without a peer in all Central America.

Of Antigua itself many interesting ruins remain, for though it is now a town of several thousand in-habitants it is essentially a city of the past. The new lives but in the old Everywhere above the lowly dwellings of to-day tower the ruined churches—vast, high arched and domed—with battered belfries in which the old bells still summon the worshippers to prayer in some improvised chapel in the ruins below The vast majority are however roofless and tenanted only by the flickering shadows of the present and the memories of the past Where once swelling anthems pealed and proud hidalgo knelt in prayer, wild flowers grow in tangled profusion and creeping tendrils cling Grass waves knee deep upon many a roof and cloistered courts re-echo but the flutter of beating wings. Far down where the Inquisition flourished the rat alone steals stealthily on its way or weird iguano creeps to light like some poor tor-tured soul The dismal cell of monk or nun stares out upon the world with fallen roof and gaping doors, a feed ng ground for the lowly hog

San Francisco, the greatest church of all contains behind triple bars in a little chapel within its walls the remains of the holy Betancourt, who in his day performed many miracles they will tell you and who it is believed will ere long be canonized Pilgrim-ages are made to this shrine from miles around the penitents going on foot to obtain the full benefit thereof Then it is that Antigua assumes the air of the present and is to be seen in her gayest garb, and that the shrine of Betancourt fairly bristles with small wax images of the man woman and child of the head arm or leg which it is hoped will be cured

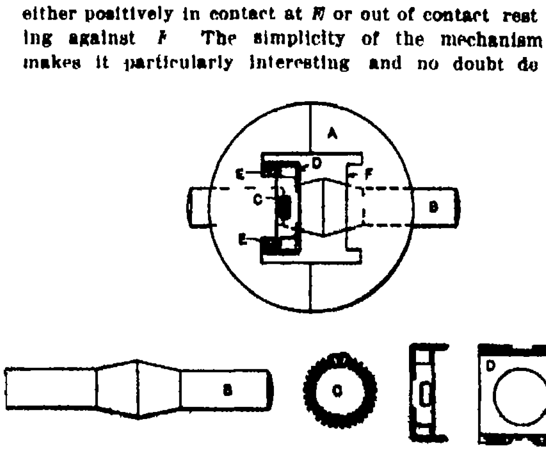
The Indians come from many distant villages for now they have adopted the God of the stranger though still the nagual lives for each and far down down in their hearts at times they feel the old gods stirring

The fiesta summons them to the moss grown walls built by their ancestors yet no longer are they slaves and no longer does the Spaniard rule throughout the land What must be their thoughts as they cluster around their fires during the fiesta nights who can tell? For after all the native gods in winning yet have lost

And thus must we leave Antigua as the silent tropic moon shines down upon the scene of her ancient splendor—upon the walls of her crumbing churches and palaces bathed in the ruddy glare of the flickering camp fires of her former bondsmen while through the dusk loom the sweeping outlines of Agua, Fuego and Acatenango—vast silent and inscrutable—wit-nesses alike of her glory and of her ruin

Ingenious Electric Switch Mechanism

THE accompanying line engraving shows an electric switch mechanism the interesting feature of which is the simplicity of its action In the top view the mechanism is shown assembled and below are shown the three main details the casing A not being shown here Disregarding the casing the switch mechanism consists practically of only three parts First a push bar B extending clear through the switch hav ing its larger diameter in the center and shaped conically from the center for some distance toward each end as clearly shown in the illustration second a coil spring C which encircles the bar previously mentioned in such a manner that the axis of the spring forms a circle around the bar third a moving contact piece D forming a casing over the spring When this contact piece is in the position shown in the upper view it is in contact and forms a circuit at E the contact pieces in the casing A being shown cross secti ned for the sake of clearness The action of the device is simply this When the bar is pushed forward the coil spring rides up on the conical sur face until it reaches the center of the bar all the time preventing the contact piece from releasing from con tact at E until the spring has reached the central and highest part of the bar At this moment it suddenly contracts and moves swiftly along the conical shape on the other side of the highest point of the bar car rying with it the moving contact piece D and releas ing it from its contact at F bringing it against the other side of the casing at F It is not possible to move the contact piece part way and let it slip back again drawing an arc which burns the contacts and eventually destroys them The contact piece must be either positively in contact at E or out of contact rest ing against F The simplicity of the mechanism makes it particularly interesting and no doubt de vices using the principle employed would be success ful in automatic machinery for positive and in stantaneous "knock outs" and stops of various de scriptions —*Machinery*



INGENIOUS ELECTRIC SWITCH MECHANISM

Interesting Plant Discoveries

AN agricultural explorer of the Department has spent the year exploring the plant resources of southwestern Asia. Among the large number of interesting things he has secured is a variety of alfalfa from Erivan which is said to be longer lived than the Turkestan a species of medicago from an altitude of over 4,000 feet whi h is already being utilized in the work of creating new hybrid alfalfa for the northwest a wild almond from the Zarafshan Valley found growing on the dry mountain sides at an altitude of 6 000 feet; a drought resistant cherry for home gardens in the northwest and a collection of apricots with sweet kernels from Samarkand the Afghanian apple and special varieties of pears for trial in the Gulf states; some remarkable olives which have withstood zero temperatures and still borne good crops of fruit; late and early varieties of Caucasian peaches for trial in the southwest seeds collected in the Caucasus from wild plants of the true Paradise apple which is used as a dwarf stock for the purpose of obtaining seedlings not infected with crown gall; scions of a newly pro-duced crab apple, reported to be a better keeper than American crab apples; the new abrikose, a variety of apricot with a skin as smooth as that of a nectarine; a remarkable drought-resistant poplar for the middle west and a wild strawberry, fruiting at the end of February on the dry calcareous cliffs of the Caucasus.

In view of the varying data published concerning the solubility of gold in nitric acid, F. P. Dewey has carried out experiments which show that gold is dis-solved to some extent when treated with the purest highly purified acid. The method employed to deter-mine the amount of gold in the strongest acid solu-tions is described.

Securing Efficiency in Railroad Work

Mr. Harrington Emerson on the Right Way to Do Things

The question of efficiency and economy in the management of industrial enterprises has of late been much discussed, both in the daily press and also in the more technical papers. One contribution to this subject, which commands immediate attention owing to its high character, its direct connection with work actually performed on a large scale, and, last but not least, the numerical examples, drawn from practice, with which it is illustrated is a paper recently read by Harrington Emerson the eminent expert, at the invitation of Harvard University Early in 1904 Mr Emerson was retained by the Santa Fé Railway to inaugurate and direct such reforms as might remedy an inordinate rise which had occurred in the running expenses of the railway during the years immediately preceding The state of affairs which prevailed is well brought out in the following table showing figures collected from the president s annual reports

	Cost per locomotive mile for repairs	Cost of repairs per locomotive	Number of locomotives	New locomotives secured	Cost of repairs per ton of locomotive weight
1897	$0 045				
1899	0 0558	$2 032	1 083		
1900	0 0592	2 096	1 136		
1901	0 082	2 858	1 174	52	
1902	0 0922	3 156	1 312	169	
1903	0 0867	3 042	1 309	130	$38 45
1904	0 1134	3 772	1 433	151	40 23
1905	0 1256	4 165	1 454	36	46 23
				538	

A diagnosis of the causes of this rise revealed a number of influences at work Briefly stated the problems which were confronting the company were of threefold character namely (1) Physical—to cope in prompt and adequate manner with the necessary repairs in shops which had become run down which were mostly antiquated and manned with mechanical employees, most of whom were not only at the time striking, but were very hostile to the company The enormous increase in business which was taking place at this time made it imperative to find means to make the best of the existing equipment as it was quite impossible to build and equip new shops in time to take care of the increased deterioration of the overloaded equipment (2) Financial—to check the alarming increase in expenses (3) Moral—to eliminate radically and permanently the strain and hostility between employee and employer

Before going on to point out more in detail some of the methods followed and results secured by Mr Emerson in the attack of these problems we will pause to consider some of the fundamental principles upon which his plan of campaign has been framed principles which for their convincing simplicity and extreme importance claim our most careful attention and supreme interest

One short sentence with which Mr Emerson heads one of the sections of his paper expresses the essence of the fundamental principle which lies at the bottom of his method This sentence reads "Separate operations are often connected in dependent sequence In exposition of the purport of this sentence we can do no better than quote Mr Emerson s own words He says in part as follows "Lifting a load is one operation carrying it is another If a path is so bad that a good man can only take half the load and walk only half as fast his carrying power is reduced to one-quarter through no fault of his own Thus fifty per cent efficiency as to load and fifty per cent efficiency as to speed results in twenty five per cent mile-pound efficiency If the man is in addition slow and lazy if under any conditions he moves at half speed and takes only half reasonable load, he will carry only a quarter as much and walk only a quarter as fast so that the end efficiency is only 6 25 per cent or only one-sixteenth of the standardised task. Grant a man efficiency of 90 per cent and a condition-efficiency of 80 per cent, hence a combined condition and operation efficiency of 72 per cent, and assuming operations averaging in two-fold dependent sequence and the end result will be 72 per cent of 72 per cent, equal to 51 84 per cent When an investigation shows an end efficiency of 50 per cent, it does not follow that the workers are as low as 90 per cent or that conditions are as low as 80 per cent, since dependent sequences may average three four even five or six or more Assume men at 100 per cent and conditions at 90 per cent in six fold sequence, and the end result is only 53 14 If all the operations in a shop average 95 per cent the shop as a whole may average anything from 95 per cent down It requires but a brief moment s reflection once this matter is brought home to us to realize with what avalanche power the losses due to even comparatively slight defects in the individual steps may rise in a process in which a large number of dependent sequences are involved And obviously processes of this kind in industrial and manufacturing work are the rule rather than the exception Furthermore the improvement which can at times be effected in the efficiency of one single step in the sequence is sometimes vastly greater than anything that has been considered in the figures quoted above For example the cutting power of steel upon steel has in the past been improved from eight pounds an hour to 1 600 pounds that is to say the efficiency has been raised from 0 5 to 100 per cent Dependent sequences are often as many as 50 in a series

Passing on now from this exposition of the fundamental principle underlying Mr Emerson s work we proceed to consider a few instances which show how and with what success the principle has been applied to some concrete cases

The first example which Mr Emerson cites as an apparently trivial and yet thoroughly characteristic step in the extensive reform which took effect at the Santa Fé Railway under his guidance relates to the cost of maintenance for belting in the shops of the company When Mr Emerson s work began it was found that this item being regarded as of altogether minor consequence was left in the care of no particular person with the result as will presently appear that the efficiency in this department was execrably low Remembering our fundamental principle we dare not despise any attentions paid to this detail or any other for belting is more important than it seems it is a link in a chain Every belt failure entails a dependent sequence of loss as the broken belt puts machine and man out of commission delays the work in progress holds locomotives in the shops prevents the moving of trains lessens revenue in an endless This is the house that Jack built series

For the year ending June 30th 1904 the cost of new belting had averaged $1 000 a month and belt failures had averaged 300 a month By careful attention to the quality of belts purchased and to the way in which the work of belt repairing was being handled these figures had been reduced by May 1905 to $163 a month and forty three belt failures respectively The above is merely one perhaps seemingly trivial example of the kind of progress that has been made in every department in which time has hitherto permitted the application of the economic principle illustrated A large number of figures might be quoted to show this, but we must be contented here to pick out a few of the most striking Probably the most extreme instance of the waste which may occur through neglect of the correct economy principles is the showing made under the heading Fuel This represents the largest item of expense on most railroads On the Santa Fé the fuel paid for amounted to an average of 250 pounds for every thousand tons weight of freight trains per mile Actually measured consumption on test runs of freight trains proved to be about 80 pounds instead of 250

According to the *Erie Railroad Magazine* for September 1910 the average amount of coal used per mile by its passenger locomotives is 108 pounds One division was selected for special supervision and its average was soon brought down to 79 5 pounds per mile One locomotive in this division was singled out for a six days test during which its coal consumption was reduced to 35 1 pounds per mile A switch locomotive is reported by Mr W C Hayes of the Erie Railroad in the case of which a fuel consumption of 2 088 pounds under common working conditions was in a test with increased work reduced to 720 pounds

The great contrast between some of the figures taken from common practice and those obtained when proper care has been taken is due to the ten links of dependent sequence between the coal mines and the ash pit The ten links are

Coal charged by the mine but not delivered to the car Coal shrinkage in transit Coal shrinkage in unloading Coal shrinkage in bunker Coal shrinkage in loading Coal wasted in roundhouse before locomotive takes train Coal lost through wasteful firing Coal lost in wasteful running Coal burned while waiting on side tracks Coal lost to ash dump especially when fire is pulled

Of one more department to which Mr Emerson gave special attention we can here speak only very briefly namely the one to which we have referred at the outset as one of the three phases of the problem at issue the moral phase Mr Emerson has shown most clearly that the best efforts are put forth by the men the healthiest feelings on their part toward their employers are bred under a system of properly regulated efficiency rewards Perhaps no better evidence can be brought forth of the spirit thus engendered than by quoting the words of Mr D F Barton foreman of the Topeka shops of the Santa Fé Railroad as he addressed the Railroad Foremen s Association The efficiency system is distinctly co-operative It changes the men from half hearted listless idle indifferent workmen to striving alert active intelligent honest self respecting workers who take an intense interest in the work at hand and are willing to do whatsoever their hand finds to do with all their might Numerically the character of the bonus system as well as its results is brought out with great clearness in the following table

	April 1902	April 1909
Passenger locomotives turned daily	6	7
Freight locomotives turned daily	18	13
Gross tons handled	77 742 800	152 430 860
Mechanics wages per hour	$0 375	$0 42
Average bonus per hour		$0 043
Pay roll	$16 813	$17 813
Bonus paid		$1 849
Number of men	260	223
Locomotive failures	57	11
Miles between failures (all)	4 377	
Miles between failures (passenger trains)		17 683
Miles between failures (freight trains)		29 995
Miles between failures (all)		47 678

The last three items alone in this table showing a total of 4 377 miles between failures in 1902 and 47 678 miles in 1909 after the reform had gone into effect are enough to impress the most skeptical with the enormous importance and value of such methods as are advocated and taught by Mr Emerson We may well pause to consider what such reforms would mean to the individual and to the State if introduced not in merely this or that branch of some single industry but to entire systems and to the whole industry of our country

A New Impact Testing Machine

In a recent number of *Engineering* Mr R. D MacLachlan describes a machine on the principle of a weight falling on a plate and applying an impact tensile load. With such machines it is desirable that the load should be applied directly, so that as little as possible of the energy of the falling weight is lost in the intermediate connections. In the machine described the plate which receives the blow is made very stiff and is screwed directly on to the specimen. Precautions are also taken to insure that the blow from the weight on the specimen is a fair one, [illegible] well as tension stress [illegible] The weight [illegible] is of cast iron, accurately turned to fit the central rod and it weighs 82 04 pounds It is raised by means of a windlass A small key on the tup runs in a key way on the central rod, to insure that there is no rotational motion of the weight when falling The energy absorbed in fracturing the specimen is measured in two ways (1) The velocity of the falling weight is measured (2) the kinetic energy of the weight after fracture is recorded The second method is not considered so satisfactory as that of measuring the change in velocity Preliminary tests are recorded A bar of mild 5/16 inch steel of commercial quality was selected Test pieces were screwed ⅜ inch and turned and accurately ground to ¼ inch diameter for the middle 2 inches The specimens were subjected to different heat treatments with the object of determining the effect of such treatment on the power of the material to resist shock In all cases the elongations due to impact testing are greater than those due to tension testing Increase of temperature during annealing appears to reduce the total extension under the static load and the impact load The effect of cooling the specimens in water is very marked the elongation in both static and impact tests being much reduced The preliminary tests showed that the measurement of the velocity on the drum of the chronograph was not satisfactory A stroboscopic method has been adopted which is a great improvement.

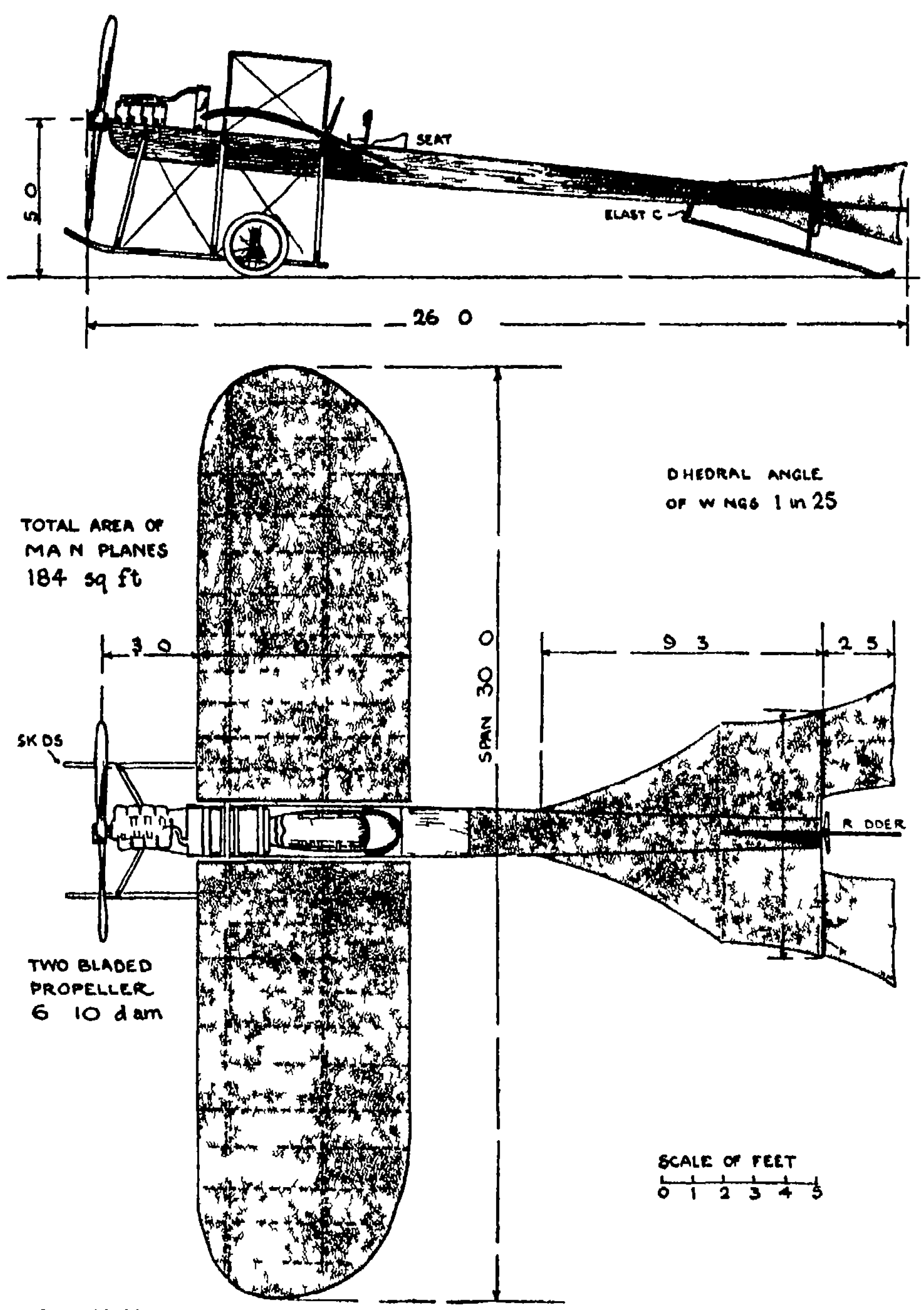
The Hanriot Monoplane

The Construction of a Remarkable French Flying Machine

Wherever it has been seen the Hanriot monoplane has invariably attracted attention and more often than not received favorable criticism of its shipshape appearance. And now that it is about to be brought to the fore in this country under the ægis of a powerful syndicate the interest that it has awakened in the capacity of a mere visitor at some of our flight meetings is likely to mature in a more practical form among those who have an ambition to fly. There are many points of distinct originality in the Hanriot design and construction but it is not always that these features in question are appreciated individually as such by those on whom their *tout ensemble* makes a good impression. First and foremost here is of course the wooden boat-shaped hull that naturally strikes everyone at first sight as the outstanding departure from orthodox practice but there is also the A type frame that supports this body upon the wheel and skid chassis and those who attended the previous Paris Aero Show will doubtless remember that a similar feature of construction characterized the Hanriot monoplane of last year. It was one of the most interesting constructional details that this exhibition brought to light. Simple in design and construction strong in principle it formed a clever solution to a problem that it has not been easy to turn into a really neat job that the method has been generally appreciated may be judged from the fact that several other makers of monoplanes subsequently adopted the essential features of this design.

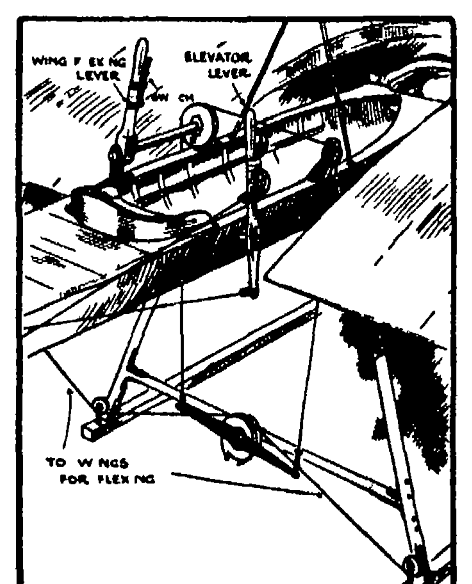
There is also a good deal to be said in favor of the boat body on the Hanriot monoplane and quite apart from any intrinsic merit that this system of construction may possess on its own account there is a distinct advantage in the system in that it dispenses with the use of a tremendous amount of wire that would otherwise be necessary for bracing some equivalent girder member. We have no objection to wire in principle and unquestionably it is a wonderfully strong and light method of building up a frame but on the modern aeroplane there is so much wire that any method of reducing the amount is welcome on this score alone. Wire bracing needs some little attention for it should at least be periodically inspected and if more wire is used than is absolutely necessary it seems to us that there is just the likelihood that it may provoke carelessness with regard to its proper maintenance. By the use of a boat body the Hanriot monoplane is clear of all wire for which a suitable substitute can be provided and those wires that do remain take on in consequence an added importance that should insure their proper attention. It may perhaps seem a little outside the zone of present day conditions to bring forward a criticism of this description but it must after all be remembered that manufacturers essentially hope to obtain a fairly wide sale for their machines and many aeroplanes are quite likely to pass into the hands of users who will not always realize the necessity of persistent attention to small mechanical points while their chief object is to get up into the air. The wider and the more rapid the development of aviation the more is this likely to be the case—as it has been for instance in connection with motor cars—so that in considering the construction of machines, it is necessary even now to take note of features such as these because of the influence that they may have on future design.

The boat body of the Hanriot monoplane is constructed on the lines of a racing skiff, and it is well known that this form of construction produces a very strong and very light girder. The top of the body is entirely decked in, except for a little cockpit containing the pilot's seat. Immediately behind the pilot's seat the deck is thickened so that it is safe for the pilot to stand thereon when mounting and dismounting. No wires of any description interfere with free access to this part of the machine. Three steel strips form a kind of cradle for the support of the body on the A type chassis frame the strips being bolted to the inclined struts of the frame and passing under the body as shown in one of the accompanying sketches. Steel strips are also employed for lashing the main spars of the wings to the body and it will be observed in the same sketch how these spars are mounted on blocks and lashed in place as described. The spars are not horizontal but are set at an angle to one another the dihedral being 7 inches that is to say the extremities of the wings rise 7 inches above the shoulders. The spars in question are 3 inches deep and 1¼ inches wide and they are constructed on the three-ply principle instead of being cut from one piece of wood. This is a departure from common practice that we have not noticed elsewhere, and in view of the criticism that has been levelled against the supposed tendency of monoplane wing spars to buckle this method of construction will doubtless arouse interest. The laminæ of the spars are arranged vertically but again bearing in mind the matter just referred to it is conceivable that some use might be made of this principle with horizontal laminæ to strengthen the spars against the forward pressure. It is the end thrust on a machine that is the difficult force to meet. The vertical forces can be more readily provided for because the presence of the propeller in no way interferes with any system of bracing that may be preferred. In the Hanriot monoplane it is worthy of note that the rear spars of the main wings are individually trussed by a diamond bracing each spar being fitted with a vertical cross strut in the center and the four extremities being tied by diagonal wires. The rear spars are hinged to the frame so that they can rock for wing warping and the hinge pins are tied together by a steel tube so as to relieve the body of undue strain.



From *Flight*

THE HANRIOT MONOPLANE 1910



From *Flight*

DIAGRAMMATIC SKETCH ILLUSTRATING THE SYSTEM OF HAND CONTROL ON THE HANRIOT MONOPLANE

A pivoted foot bar not shown operates the rudder

The control of the Hanriot monoplane is mainly interesting on account of the use of two levers one under the control of the pilot's left hand and the other under the control of his right hand. That on the left moves sideways and operates the wing warping that on the right moves to and fro and controls the elevator that forms a hinged extension of the tail plane. In front of the pilot's seat is a pivoted cross bar that can be rocked by the pressure of his feet. This controls the rudder which is mounted between the halves of the elevator. The fixed tail plane on the Hanriot monoplane is quite flat, and consists of a sheet of fabric tightly stretched by the aid of a couple of transverse spars. The rear portion of the tail plane is deflected a little below the line of the leading portion, to which it has a relative, although small, angle of inclination.

Well forward of the main planes is the engine, which on this machine is an [illegible] E.N.V. This is mounted in the bows of the boat body and is also partly supported by the struts of the A

these, a pair of which are situated immediately beneath the motor. The tractor-screw which is direct driven by the engine, is 2 1 meters in diameter and 1.3 meters in pitch. When at rest on the ground, the machine is carried by a pair of pneumatic tired wheels in front and by a light trailing-skid behind. The wheels are mounted on a steel axle that is reinforced by a wood batten and mounted in vertical guides so that it has a considerable upward travel. Suspension is effected by elastic springs anchored to the main skids and attached to the upper end of a column that rests upon the axle itself.

Working Distances of Wireless Stations

Methods by Which Efficiency is Obtained

By W. C. Getz

In looking through the technical inquiry portions of this and contemporary magazines the reader will find invariably that fully 75 per cent of the questions asked about wireless telegraph are of the "How far will it work" type. At first glance this may seem a logical question to the uninitiated, but upon a moment's reflection the utter worthlessness of any stereotyped or

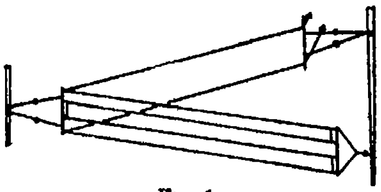


Fig. 1

cut and dried data based on such insufficient information as the height of the aerial or capacity of the spark coil, without a detailed knowledge of the operating conditions and environment, is easily apparent.

While heretofore the editor has probably answered these questions basing his deductions upon performances of similar apparatus that has come under his observation during his greater or less experience in the wireless field, it is now time to bring to the attention of the experimenters, and particularly to the young amateur who has an extremely limited knowledge of electricity and who is therefore more greatly imposed upon by irresponsible firms, the futility of such inquiries and subsequent answers.

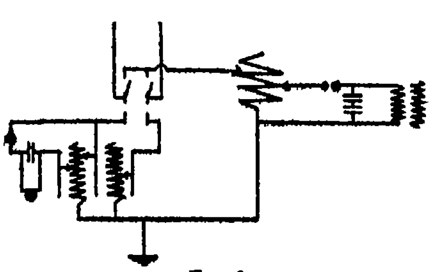


Fig. 2

Such questions as these, while asked in good faith, cannot be answered any easier than a hypothetical question recently asked the editor of a photographic journal—the party writing wishing to know if the editor considered a man weighing 180 pounds and owning a dress suit competent to lecture on "Color Photography," without the editor ever knowing any more about the man than was stated in the inquiry. Individual conditions alter all cases, and it is the purpose of this article to show the great many conditions that enter into the subject of wireless telegraphy, and which, unless carefully studied and complied with, may greatly alter the results from what was expected.

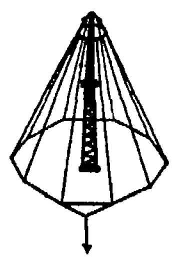


Fig. 3

The efficiency of a wireless station depends on the following general points:

1. System or "hook-up" used.
2. Locality of station.
3. Height of aerial.
4. Capacity of aerial.
5. Sensitiveness of apparatus.
6. Intelligence and care used in connecting and adjusting the necessary apparatus.

Each and every one of these points will cause a difference in the working distance of a station, and as it is hardly possible that there are two stations exactly alike in all of the above points, it is therefore manifest that no formula or rule can be derived that will cover the effective range of any and every station.

A brief discussion of some of the above points may serve to enlighten the experimenter on certain details which may be the cause of some inefficiency of the particular station in which he is interested.

The system or wiring diagram used causes more controversies than any other of the above points enumerated. Fundamentally every wireless circuit contains a variable or constant inductance and a variable or constant capacity. Various combinations of these have been evolved into different systems, each so-called "system" having its stanch adherents who set forth claims of unexcelled superiority in "selectiveness," "long distance," etc., that may be really due to a fortunate combination with the local conditions in any particular case. It is well known to the majority of experimenters that certain "hook-ups" seem to work better at one station than at another, and as no rule can be assigned to cover this, the experimenter getting the best results is usually the one who is not content with one diagram until he has thoroughly tried out

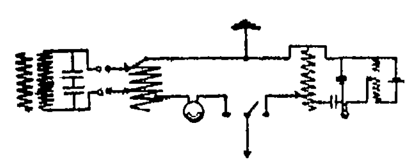


Fig. 4

all. Such diagrams have been issued both in book and blue print form for the past year and a half, and the amateur who neglects obtaining the best and most recent copies of these diagrams is usually the one who never has "results" with any apparatus.

In considering the second point—the locality of the station and its effect on the working distance, we must depend upon the experience of others and base our assumptions accordingly. On water it is conceded that wireless can be worked over twice the distance for a given equipment than can be done over land. While nearby mountains do not cut out the waves as was first assumed, it often happens that in mountainous regions a good ground is hard to obtain. And again ore-bearing mountains if near at hand in some instances have noticeably reduced the efficiency of a wireless set, especially where the ore is of a magnetic nature.

Fig. 5

Water itself does not always form such a good ground, as the resistance of clear water containing mineral or vegetable residue is very high. The best ground is a copper plate or wire netting placed in loam that is permanently moist. A ground plate buried in clay is usually inefficient, and sand unless wet has a very high resistance. A station in the woods will lose much of its transmitting energy if the aerial is near any trees. For this reason when it is necessary to guy the antenna to trees, strain insulators should be cut into the guy wire at equidistant intervals to reduce this leakage factor.

Where static is prevalent the receiving efficiency is somewhat decreased at times owing to the inability of the operator to read through static. By shunting a variable condenser around the detector this annoyance may be greatly reduced, but at the expense of receiv-

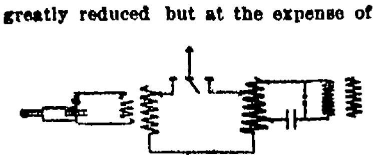


Fig. 6

ing radius. The proximity of power wires sometimes causes electro-magnetic induction in the receiving set. The use of the "loop" form of aerial greatly eliminates this trouble.

The height and form of aerial also varies the distance of operation. There is no rule governing the relation between the aerial height and the effective radius of communication, although Marconi at one time stated the distance was proportional to the square of the height of the antenna for a given set. This of course does not hold good with the present

Fig. 7

type of wireless apparatus, as the instruments now on the market have many times been successfully used over distances one hundred times greater than the aerial height squared.

The main consideration is to have the aerial perfectly insulated. The number and size of the wires used in the antenna depend entirely upon the capacity of the station. When a brush discharge is observed from the aerial, it is generally a safe sign that more aerial wire is required.

The form of aerial, whether straight, cage, flat top, loop, umbrella, etc., can only be determined after a thorough trial is made of each and the results classified, so that the one giving the best results for the individual and particular station is ascertained. The capacity of the aerial varies according to the different forms and dimensions used.

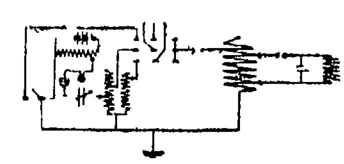


Fig. 8

The relative sensitiveness of the instruments used is a subject that the writer would like to omit, as there is bound to be a difference of opinion on the same, and this is intensified by the fact that every manufacturer differs radically in certain designs and each has an abundance of testimonials to show that his is the only right and efficient way. However, the writer has tried to take a view of strict impartiality, and trusts that if he unknowingly wrongs any one they will write and inform him of the case. As there are now several score concerns making and selling wireless apparatus, and thousands of amateurs are also making their own instruments, certain well known and standard types will be discussed, and the experimenter may govern his conclusions in proportion to which his instruments approach these standards in efficiency.

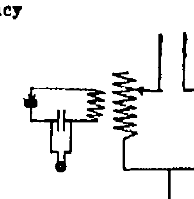


Fig. 9

It is not to be supposed that an instrument costing but a few cents will give as good results as a well made and reasonably but higher priced instrument. For instance, the so-called silicon crystals sold to experimenters by some wireless concerns will not give 50 per cent of the efficiency of the improved silicon detector which is designed and tested for sensitive work. The crystals in the latter are selected from specially imported silicon, and many lumps are rejected before a sufficiently sensitive piece is found. In a like manner the efficiency of any other instrument depends upon the sensitiveness of the individual instrument itself more so by far than on the type of instrument.

On the receiving side the detector is the vital part of the set, without which it is impossible to operate

In the order of their sensitiveness the following types of *standard* detectors have been classified

Class A Electrolytic (silver plate wire 0 0001 inch / 0 00002 inch) perikon

Class B Silicon (improved) pyron Ferron.

Class C Molybdenite

Class D Carborundum Magnetic Electrolytic (silver plate wire 0 001 inch / 0 0001 inch)

Class F Carbon and st el Al iminium and steel Coherers etc

The Perikon detect r is the r st extensively used type for sensitive w rk as it may be easier adjusted and kept in adj stm nt than any other used in practi cal work

The telep h n rec ivers should be of high resistance with a maximum amount of ampere turns per ohm re sistance In this respect enamelled wire is far su perior to silk insulated wire and a number of pro gressive firms are following in the track of the writer who had used enamelled wire for receiver windings for the past several years Low resistance receivers are of no use whatever for sensitive work

The tuner may be of the inductive type or of the familiar auto-transformer or single winding type The latter may have one two or three sliding contacts It has been the writer s experience that excellent re sults were always obtained with th double sliding contact tuner The use of a third sliding contact is now being advocated by certain manufacturers who claim better selectivity with the same The inductive type of tuner is considered to be the most sensitive

Apropos of the discussion now being waged among the several manufacturers regarding the use of enamelled wire on tuners, the writer has used a num ber of tuners wound either with bare, enameled, or cotton insulated wire, and he could not notice any marked difference in the respective efficiencies.

Condensers should have about from 0 001 to 0 005 M F capacity The potentiometers should be at least 300 ohms resistance when two or more cells of bat tery are used

On the transmitting set the relative efficiency of the induction coil or open core transformer and the closed core transformer seems to depend upon the re liability of the builder Both work well when properly and intelligently used Where only direct current is available it is not advisable to use the Wehnelt in terrupter as it gives very poor results on wireless work By no means use it on alternating current, as the best results are obtained when the primary is connected direct to the A C mains, suitable resistance or impedance being inserted in series if necessary

The sending inductance, spark gap and transmit ting condenser can be of any make that uses the gen eral proportions of the standard types. The wire of the sending inductance should not be on less than a three-inch radius and should be No 14 B & S gage wire or larger The spark gaps should have elec trodes of zinc or of some other approved alloy con taining a sufficient amount of zinc to produce the char acteristics that accompany the use of the zinc gap

The current supply for the transmitting side should always be sufficient for the maximum amperage re quired by the transformer or coil when operating in order that the spark may be maintained smooth and regular

The [illegible] and [illegible] of the [illegible] [illegible] really in the [illegible] to accomplish. It [illegible] that he should try [illegible] changes of his [illegible] and capacity and [illegible] the readings of his hot wire meter in the aerial leads with the distinctness in which surrounding stations are able to receive him. If this is done in a system atic manner, each receiving station making a record of the clearness, and condition of spark, etc, thus be ing noted, the actual tuning may be easily and ac curately accomplished.

A small power station tuned properly will probably work four or more times as far as one of double its power but not in tune. The main consideration is to know what you want to try, and then to try it in the simplest and most systematic way possible. The per sonal element of good judgment and care in making the connections good is more responsible for some of the record results accomplished by certain experi menters than the type of apparatus employed.

The following information has been prepared for the use of the experimenter who wishes data on some stations that may have conditions somewhat similar to his particular station and while this is only com piled from the operation of certain particular stations, the facts may be of use in 'doping' out the probable results of apparatus that is to be installed The ex perimenter is again cautioned that his results may differ widely from those given herein and that the only way to get the best results is to experiment with as many hook ups and instruments as you can, until the happy medium is obtained—*Electrician and Mechanic*

								RECEIVING INSTRUMENTS						TRANSMITTING INSTRUMENTS							
Example No.	Local Conditions	Ground	Atmospheric Conditions	Height of Mast	Type Aerial Sketch No	Diagram No.	Detector	Tel. Rec	Tuner	Condenser	Potentiometer	Battery	Receiving Radius	Coil or Transformer	Inductance	Condenser	Spark Gap	Source of Power	Watts used	Transmitting Radius	REMARKS
1	On Hill 3 miles from Tide Water	To City Water Mains	Static in Summer	40 ft.	Fig 1	Fig 2	Silicon (Improved)	2 each 1 650 Ohms No. 40 Wire	1 Single and 1 Double Slide Tuner	002 M F	None used	None used	200 miles	1 in Spark Coil	No 12 Wire 5 turns 18 in. Diam.	Leyden Jars, 2 each 6 x 2 in. Diam	Zinc ¼ in. Electrodes	Storage Battery	200	10 to 15 miles.	Tuning Good
2	On Rocky Hill 500 feet from Water	Poor Copper Plates in Sand	Good No Static	100 feet (iron)	Fig 3	Fig 4	Perikon	2 each 2,000 Ohms	Double Slide Tuner	006 M F	270 ohms	1 Cell 1 1 Volt	350 miles	1 K.W Open Core Trans	No 6 Wire 12 turns 10 in diam	26 Plates each 10 x 12 in.	Zinc ¼ in Electrodes	110 Volt A C.	1100	35 to 50 miles	Metal Mast—absorbed energy greatly
3	On Rocky Land 1 mile from River	To City Water Mains	Good	60 feet	Fig 5	Fig 6	Ferron	2 each 1,600 Ohms	Inductive Tuner	004 M F	None used	None used	600 miles	1 K W Open Core Trans	1 10x1 2 in. Strip Copper 20 turns	20 Plates 8 x 10 in.	Zinc ¼ in Electrodes	110 Volt A C.	1200	40 miles	Transmitting side not well timed
4	In Country near Woods	To Pipe in Well	Static Prevalent	80 feet (2 Trees)	Fig 7	Fig 8	Electrolytic 0011 in 1 00002 in Wire	2 each 1 000 Ohms	1 Single and 1 Double Slide Tuner	0001 to 010 Adjustable	350 ohms	2 Cells Dry Battery	880 miles	¼ in. Spark Coil	No 8 Wire 20 turns 12 in. diam	10 Plates 6 x 8 in.	Brass ¼ in. Electrodes	Dry Battery 8 cells	60	18 miles	Tuning of transmitting side excellent.
5	Near City 10 miles from River	Moist Earth in Cellar	Good	50 feet	Same as Fig 1	Same as Fig 4 Rec	Electrolytic and Silicon (Low Grade)	2 each 200 Ohms	Double Slide Tuner	004 M.F	Graphite Rod	2 Cells Dry Battery	20 miles at greatest	1 in Coil	None used (Untuned)	None used	Brass Balls ¼ in. diam.	12 Fuller Cells	100	¼ mile	Poor instruments, no tuned trans., and careless adjusting Used properly would work better
6	In Valley near Bay	Moist Earth	Fair	15 feet	Same as Fig 1	Fig 9	Perikon	2 each 1 600 Ohms	Inductive, also 1 Single Slide Tuner	Adjustable 006M F and 1 Fixed	None used	None used	.370 miles	No Transmitting Apparatus							Extremely selective Intelligent adjusting. Careful experimenter.

Our Soda Lakes

Freaks of nature aside from their importance to the scientific world and as curiosities for the vast army of sightseers to gaze upon sometimes afford humanity a source of supply for many of the neces sities of life The latter is true of the Soda Lakes of Nevada or as they are locally called the Ragtown Ponds The waters of these lakes are strongly alka line and as their name would imply contain large quantities of soda

It should be mentioned that there are but two of the lakes The larger covers an area of 270 acres its greatest dimensions being about a half mile wide by three-quarters of a mile long while the other is con siderably smaller

Aside from the make up of their waters the right to class these lakes with the freaks of nature is based also upon the fact that there are no visible streams tributary to or draining them their entire water sup ply except the small amount derived from direct pre cipitation being supplied from subterranean sources A study of their formation and water supply has been a theme for scientists during the past half century Some claim that the Carson River is the source of supply The bed of this river at its nearest point which is some two miles distant is fifty feet above the surface of the lakes These bodies of water them selves occupy two circular depressions in the earth which geologists claim to be craters of extinct vol canoes and it is said that the water from the river reaches these craters by percolating through the in tervening earth the mineral matter contained therein being unquestionably derived from the deposits of its subterranean passage.

These phenomena lie but a short distance off the old cross-continental trail used by the forty niners in their mad rush to the gold fields of California, and are situated right in the heart of the Carson Desert. The nearest town to these lakes is Leetville but in the days gone by it was known as Ragtown

Nestling in the banks of these strange lakes in deed within a few feet of their very edges are to be found springs sending forth continually streams of the purest cold water free from any taint of soda or alkali Had the early pioneers known that such an elixir of life flowed in that deathlike place how many lives might have been saved

The rim of the greater lake rises eighty feet above the level of the desert but so gradual is the slope that one approaching is not aware of the existence of such a body of water until the very brink is reached Standing on the rim for it can hardly be referred to as a bank one gazes down at the glass surface of the salty water one hundred and sixty five feet below In early days these lakes were believed by many to be bottomless no doubt a belief that still exists among a certain class Of course every body of water must have a bottom and careful measurements have shown the greatest depth of these bodies to be in the neigh borhood of a hundred and fifty feet.

The manufacture of soda from the waters of these lakes was begun a good many years ago, and is car ried on by the simple process of evaporation It is estimated that the two bodies contain more than a million tons of soda—enough to supply the whole world for a good many years to come. Time was when ocean plants supplied the raw material for soda, and it was the French Revolution which effected the first great revolution in the making of that necessary article of every-day use When France was isolated from the world her eminent scientists were called on to save the country from a threatened soda famine and as a result Leblanc invented his process for the manufacture of soda from coal, lime, salt and sulphuric acid

The Asiatic Brick

We should hardly expect to learn much of the arts of civilized life from the tribes of Central Asia, yet, it seems, they make better brick than we turn out. The barbarians employ the same material that we do, and curiously enough the thing that imparts superi ority to their process of brick making is one of the most powerful agents of western civilization—steam.

When the Asiatics have baked their bricks for three days, the opening of the oven is closed with felt which is kept wet, so that the bricks still intensely heated are enveloped in steam.

The process causes a remarkable change in the character of the bricks. From red they turn gray, and at the same time acquire a remarkable degree of toughness and hardness. Although porous, they give out a sound, when struck, like that of clink stone, and they are said to resist the effects of weather much better than do the bricks of Western make.

Necessity was the mother of invention in this case, for the climate in which these ingenious Mongols live is subject to great extremes of temperature, hav ing a disastrous effect upon bricks made by the or dinary process.

Our Typhoid Streams

A Problem of National Importance

By H de Parsons, M E

The pollution of our streams by sewage and trade wastes has become a national issue As the population increases, especially the congestion in our cities, the subject is one of vital interest to the well being and public health of our States Changes produced by settlements have created new conditions Some of these new conditions it is neither possible nor desirable to check, but there is no good reason why one community should misuse a stream to the detriment of another The economic rank of a country is based on its natural resources Of these resources her rivers and waterways are foremost Where can a rich and prosperous country be found which is not well watered? Sewage has to be taken away from the places of generation Its manurial value has not been equal to the cost of securing it Therefore, municipalities construct sewers so as to dispose of the sewage by water carriage with the object of putting it out of sight as quickly as possible As a natural sequence, sewers are built to operate by gravity and to discharge into the nearest convenient stream or body of water so that the sewage may be diluted and carried away with the currents without further attention The result is that some of our rivers are not now sufficient to provide proper dilution, and towns are drinking their own or others sewage

Philadelphia drank its own sewage before it began to filter the water supply from the Delaware River and dearly paid the penalty in a high typhoid death rate. The supplies of many private water companies are polluted and towns are refusing to accept the polluted water offered

The author examined a water shed in New York State where the drainage from a village emptied into the reservoir supplying potable water to adjacent towns Again, in Illinois the water supply for a city was taken from some small brooks and rivulets into which all the adjacent farms with their out buildings emptied their liquid wastes In this case the only effort at purification was a slight aeration of the water by being sprayed over an artificial dam in the reservoir Again in Wisconsin a city was without a municipal water supply and each house had a well in its back yard. These houses drained their sewage into open cess pools located in the same yards

Albany filters its water but even so its typhoid death rate is above the average of cities located amid clean surroundings and its sewage is passed down to other places below on the Hudson

The Ohio River is said by the Sanitary Commission of Ohio to be polluted and unfit to drink and yet it is the only source of supply for the territory lying along its banks in that State Cincinnati drinks Ohio River water and discharges its sewage into the same stream for the use of others on the water shed below The Ohio flows down past Kentucky Covington and other places in this State drink Ohio River water

The government is constructing dams in aid of navigation and in many instances these dams are located without reference to backing up sewage polluted waters into the intakes of water-supply systems

The sewage discharged from one district flows to the next district below on a stream and the process of getting rid of the sewage by dilution is not always safe nor final Sickness caused by germ life in the sewage may readily be brought back to the upper district by intercommunication of the people

It is a mistaken idea that a polluted stream will purify itself If the current is rapid the process of purification will be more energetic than when the current is sluggish But even rapidity of current is not to be relied upon as a safeguard The Niagara River is certainly rapid enough but still the town of Niagara Falls has more than its proper allowance of typhoid The distance between the point of discharge of sewage and the point where the germs are taken up is not so important as the *time* of transit. If the current be swift, the distance that the germs will travel may be very great, as some disease germs have been proven to have comparatively long lives. The pollution of streams by sewage is an active agent in the extinction of human life, and drains the wealth of a community as successfully as the sewers do the houses.

The question of pollution has become a national one, since many of our most valuable streams are interstate in their flow. A village, town, or city, when so situated as to receive the pollution created in another State, is nearly helpless to aid itself Some hold the opinion that the method of disposal of sewage is a local question to be settled by each community This opinion is not well founded Pathogenic micro-organisms are not local People are not localized but travel back and forth Contagious and infectious diseases are not local Disease caused by sewage discharged from one community may break out in another community and be brought back to the first community

Although the pollution of streams is not a local question the laws regulating sewage disposal should not be to drastic They should encourage rather than force communities to prevent pollution and should

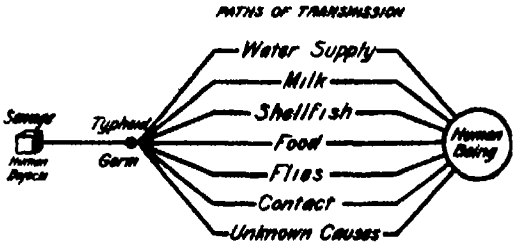


Fig 1—Paths Along Which Disease Germs May Travel From Sewage to Human Beings

be carefully drawn to fit all kinds of local conditions and be made to keep pace with the advances of sanitary engineering A mode of disposal which is suitable for one place may be quite useless in another We should not wait for an epidemic to learn our lesson We need a special authority in health matters and universal co-operation freed from all bureaucratic methods and amenable to scientific advance

Sanitarians have much to learn Our knowledge about disease organisms is still very limited and in view of our ignorance it is certainly unwise to discharge crude sewage into many of our streams Engineers should not erect structures the strength of which they cannot calculate Then why should they plan sewers to discharge into streams which may produce effects they cannot estimate?

The sewers of our cities are the place for every kind of germ harmless as well as pathogenic The sewers discharge them into the streams At first the bacteria diminish rapidly in numbers and then the numbers diminish slowly In the diminished numbers we do not find safety It is the weaker bacteria which perish first the stronger ones live longest Hard particles of sewage break up and liquefy slowly These hard particles may carry bacteria in large numbers for a long time It is a case of the survival of the fittest and of those best protected by coatings of sewage origin The typhoid bacillus as well as other dangerous micro-organisms pass the sewers to our streams. The most virulent survive

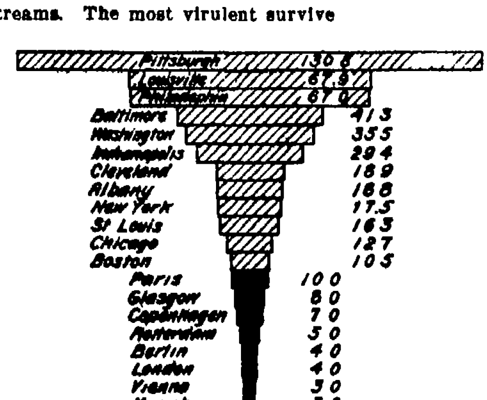


Fig 2—Typhoid Death Rates per 100 000 Population

Bacteria occupy a position in the economy of nature as the lowest known order of life in the vegetable kingdom

The real danger from pollution of streams is the scattering of germs The sources of infection are water supply, milk, shell fish food flies, contact and unknown causes Of these seven paths along which the disease germs may travel from sewage to the human being (see Fig 1) only one is guarded by filtering a water supply The other six are left open It is, therefore reasonable to state that conditions should be maintained at the sewer outfalls which are inimical to germ life, so as to reduce their numbers to a minimum This would place a barrier across every path of transmission.

When disagreeable things occur which are appreciable or apparent our æsthetic feelings are shocked But when similarly disagreeable things are not appreciable or not apparent they often pass unnoticed Thus people will go to theaters and into crowded halls and breathe over and over the same air which others have emitted They make little objection because they cannot see the particles of hair skin bacteria, and other things they breathe It is the same with pollution by sewage They throw it out of sight as quickly and as cheaply as possible without any attempt at purification and they often eat and drink it again unseen Yet these same people are so cleanly in their habits that they would refuse to wear the unwashed underclothes even of a friend to say nothing about wearing those belonging to some person ill with a disease It seems perfectly reasonable therefore that we should guard the discharges from our sewers and protect our streams so that there would be the least risk of causing sickness from drinking or eating our own or others pollution

Typhoid fever is a germ disease The bacilli may come from milk food flies or contact as well as by water The infection is traceable to sewage and the sewage is scattered on water borne in the streams It is a closed cycle disease germs in sewage—sewage in water—disease germs in man It makes little difference how many intermediate stages or steps there may be the result from first to last is the same The autumn months are often called the typhoid season although typhoid as a disease is independent of the divisions of the year Typhoid is a country disease During the later part of the summer the streams are low following the dry season and the sewage is not properly diluted and is often washed up on the banks and deposited in the shallow pools People returning to the cities after their vacations bring back with them the typhoid germs and through lack of careful nursing and neglect of ordinary precautions communicate the disease to others

As a rule the sanitary conditions existing in European summer resorts are much better regulated by the authorities than in America Tent colonies and segregations of little bungalows and cheap shacks so common in the vicinity of American cities during the summer are frequently fine breeding places for typhoid and intestinal diseases A comparison between the typhoid death rates in American and in European cities in countries where pollution is restricted is remarkable and greatly to our discredit. It does not appear that we are a dirtier people than Europeans The difference in the typhoid rates therefore is due to our careless handling of sewage Some present typhoid death rates are shown in Fig 2 and the numbers are the deaths per 100 000 population In England there is a Royal (temporary) Commission on Sewage Disposal which acts as an investigating body and as a central authority which can assist all local boards The whole subject has been closely studied since 1858 and a number of royal commissions have been appointed to aid the country Prior to this date the rivers were grossly polluted and many local nuisances had arisen Out of the Public Health Act of 1872 joint committees or boards were formed from authorities bordering on specific rivers These river boards regulate the pollution allowable in their respective rivers and there exists a certain amount of co-operation between them The work so done has been of untold value to England and the knowledge and experience collected of the greatest assistance to the world Thus for over half a century England has had some form of universal system

In Germany similar ideas are being urged and put into practical operation Each important water shed is guarded by its sanitary authority Generally speaking German rivers are larger than English rivers and this has been an advantage as it has delayed the condition of gross pollution On the other hand German rivers flow through several States and since 1899 there has existed an Imperial Council of Health which acts like a central body to which the States can appeal This may be considered as a preliminary step toward the formation of Imperial River Authorities

In France systematic control of the pollution of the rivers is less advanced than in England or Germany

In America there is no universal restriction of any general value in regard to sewage disposal Our streams are now so polluted that it is practically necessary to use only purified water in our cities But even in our cities where the water is filtered or

otherwise purified the death rate is still higher than the rates in European cities Filtering a water supply only closes one path for the typhoid bacillus to pass from sewage to man It does not protect the suburban or country districts which use unfiltered water

There are many cases of mild typhoid which do not incapacitate the patient for work Any one of these walking cases may give typhoid to another who is in a receptive state Also many typhoid convalescents are allowed their freedom who are still competent to communicate the disease As a result there can always be found residual cases of typhoid which can only be traced to unclean habits The pollution of our streams is largely responsible

As so many of our rivers and drainage areas are interstate it is necessary to have some national authority States cannot sufficiently deal with the questions of pollution as there exists in them such a diversity in laws and regulations Co-operation is wanted among the States and this can best be secured by having the assistance of the federal government that there may be less ignorance and uncertainty as to the mutual obligations of the States Let the government be the central authority through a properly organized bureau Let each State attend to its own work under the standard set by the government In this way the government bureau becomes the authority to which appeals can be made by the States and through which misunderstandings between States can be settled A national association for preventing the pollution of rivers and waterways has been organized by a number of citizens of different States all of whom are interested in sanitary science These gentlemen are carrying on the work for the public good at their own expense with the object of conserving the nation's greatest asset namely pure water It is their object to have the federal government make a study of the question with the hope that the laws of the different States may be made more uniform and that the States may be made to cooperate more closely than they do at present so as to preserve the public health There is surely truth in the saying that He who cures a disease may be the skillfulest but he that prevents it is the safest physician —*Stevens Indicator*

Electrical Notes

An Important German Electric Road —The Dessau Bitterfeld electric section of standard gage railroad is one of the most important in Germany After equipping the section it now remains to adopt the best types of electric locomotive and several firms have built locomotives for this purpose The first ones to be tested are of the Siemens Shuckert make and are designed for express trains running at 60 miles an hour The first trials of these locomotives were made not long since in the presence of an official commission including government delegates and engineers and they expressed themselves as very well satisfied with the results The present locomotives will draw trains up to 380 tons weight.

The Electromagnetic gun Idea —The thought that the giant power of a great electromagnet might be utilized to shoot a heavy projectile from a gun has occurred to many inventors Some years ago Birkeland whose apparatus for extracting nitrogen from the air is now in successful operation throughout the world calculated the power that would be needed for such a cannon and later an officer of the Austrian army made independent calculations with similar results It appears that to throw a projectile of about 90 pounds weight at a velocity of 500 meters a second a current energy of 54 300 kilowatts at 181 volts would be required But the energy is needed only for a fraction of a second Birkeland proposed to obtain it by shooting a powerful electromagnet through a set of coils by means of an explosion, but Spacil the Austrian officer has ventured the opinion that the best way would be to move large coils at a very high speed in a rectilinear direction Not much faith however is placed upon the practicability of such a gun

A Mercury tungsten Arc Lamp —Messrs Urbain and Feige of Paris are experimenting with a new form of arc lamp which uses an arc between mercury and tungsten The arc is made in a vacuum or in an inert gas inside a suitable bulb It was already known that a mercury vapor lamp could be made by using mercury with an iron electrode opposite it so that the vapor produces the light and the iron remains cold An arc is not formed in this case When we wish to make such a lamp burn as an arc lamp the iron is brought very near the mercury about one-eighth of an inch but as the iron melts by the heat of the arc this method cannot be used The authors find that tungsten will stand the heat of the arc so that a lamp can be made on this principle The tungsten glows highly by the heat and gives a strong light, but it does not appear to be consumed so that the lamp has a long life What is of interest is that such a tungsten lamp is very economical At present their experimental lamp works on 12 volts, but it is probable that the voltage can be raised so as to bring it nearer what the usual lamps take by using an inert gas under a higher pressure than is now employed The new lamp gives a very white light.

Science Notes

A New Variety of Rubber in Borneo —A new source of rubber is found in Borneo, according to a paper read on the subject before the Académie des Sciences by Prof Dybowski It comes from the milk of a plant known as *Dycra costulata* and after coagulating the milk forms a white gum known as jelutong When quite dried the matter is almost as hard as rosin, and it contains from 10 to 20 per cent rubber It is said to be superior to the best Congo rubber A factory has been recently put in operation and is now turning out a considerable amount

Berlin University Improvements —At the Berlin University some $200 000 has been expended for different improvements in the buildings especially for the new auditorium The observatory of the university is to be installed at Babelsberg near Potsdam and the work on this building is already begun At the Jena University a new building is being erected which will be devoted to anatomo pathology and it will be under the direction of Prof H Klonka The Krupp company has made a considerable donation to Prof Weichert of the Göttingen University in order to carry on aerodynamic experiments and another to the astronomer Ambronn for constructing a star photographic instrument of a new design

Adhesivity —Harriot has reported to the French Academy of Sciences the discovery of a singular phenomenon which he calls adhesivity When two sheets of brown gold are heated in contact with each other to the temperature at which they become converted into ordinary yellow gold they remain firmly attached to each other There is no action at a distance actual contact is required to produce the adhesion Hence the phenomenon cannot be due to electric or magnetic action Nor can it be due to welding caused by the softening of the metal by heat for contact produces adhesion some time after the two sheets of metal have become cold and brittle Yet adhesion is not produced by the contact of two previously unheated pieces of brown gold or yellow gold A sheet of brown gold heated to its temperature of transformation does not adhere to a sheet which has been heated and cooled several days previously The adhesion is very strong when the temperature of the hot sheet is between 570 and 660 deg F

Medicinal Plants.—The researches presented by Prof Bourquelot to the Paris Academy of Medicine appear to show that the medicinal qualities of plants are greatly modified by drying them for use and this action is much greater than may be supposed The chemical as well as therapeutic qualities are found to be changed by the drying Considerable experimental work was done in order to bring out these facts and it is shown that when the plant is dried there is an interaction of the various bodies it contains so that some of these destroy others and in this way many of the active principles of the plants are destroyed or made insoluble However it is of interest to note that this action can be avoided or at least in part By rapidly sterilizing the plants by dipping them in strong alcohol at the boiling point, the author was able to prevent any further destruction of the soluble ferments Owing to this method he could separate out the chemical principles which existed in the living plant and thus have a great advance in analysis of vegetable substances which is always a difficult matter He also prepared new pharmaceutical substances which will be likely to give very good results for medicinal purposes It will be seen that these results are far reaching and may be very valuable

Frozen Fruit.—The chemical changes produced in fruit by freezing and thawing have been investigated by Otto and Kooper For example analyses were made of ripe sloes and of the same fruit which had been kept 4 days after 5 hours exposure to a temperature of 23 to 25 deg F The loss of weight chiefly water was found to be 13 6 percent The proportion of acids decreased from 9 18 to 6 57 per cent and the tannin from 9 45 to 6 82 per cent, while the proportion of sugar increased from 30 48 to 31 75 per cent, and part of the glucose was converted into the sweeter fructose or fruit sugar The decrease in tannin 's probably due to oxidation by which the tannin is converted into red and brown substances designated as pholobaptenes The fruit lost much of its astringency and acquired an agreeable subacid flavor in medlars which had been frozen and kept 8 days after thawing the sugar decreased from 41 13 to 37 37 per cent the acids from 4 36 to 3 50 per cent, and the nitrogen from 3 08 to 2 68 per cent In Japanese quinces kept 18 days after freezing and thawing, the sugar decreased from 16 91 to 7 60 per cent, the acids from 24 11 to 12.71 per cent, and the tannin from 3 82 to 1 84 per cent.

Engineering Notes

A New Railroad Across Persia.—According to the most recent information the Russian government has approved the project for the Trans-Iranian railroad The cabinet decided upon the construction of a railroading which is to connect Baku in south Russia with India across Persia, and this line will compete with the railroad which runs from Bagdad to the Persian gulf An international company is to build the rail road.

A New System for Purifying St. Petersburg Water —The city of St. Petersburg has had trouble with bad water from the Neva but is soon to start an ozone purifying plant which appears to be the largest in Europe It handles 60 000 cubic yards of water per day and is installed by the Russian Siemens Schuckert electrical firm The system used here is stated to be a combination of the Siemens electric ozoning apparatus together with sterilizing towers designed by the Paris Ozone Company

Grain Silos —Large grain silos have been erected at Bremen at the Mühe establishment They are entirely of metallic construction and use 24 cylindrical chambers of sheet steel having 17 feet diameter and 95 feet height, taking 12 000 tons of grain This gives a very high pressure on the ground so that the constructors use a large foundation bed of reinforced concrete A bottom plate is first laid and this upholds 42 columns of about 4 feet square section Upon this is placed a reinforced concrete planking in order to receive the silos The space between the columns is used to house various apparatus for transporting the grain

A Canal from the Rhine to the Weser.—An extensive piece of work to be carried out in Germany will provide a continuous canal from the Rhine to the Weser The first section is a canal which will lead from the Rhine so as to connect with the Dortmund Ems canal then the boats will follow this latter A new section then branches off and crosses the Weser stream at Minden ending at Hanover In order to increase the flow from the Weser into the present canals there is building a barrage at Waldeck across the Eder valley and thus a basin will be formed which is one of the largest in Europe containing 210 000 000 cubic yards The barrage is about 140 feet in height It is expected to finish the present work in 1913

Peculiarities of Submarines —Equilibrium is almost as difficult to maintain for a submarine vessel as for an aeroplane With modern large submarines it is contended the act of diving is performed when the vessels have headway The bow is depressed by horizontal rudders controlled by skilled men and the vessel moves obliquely downward The desired depth having been attained the steersman must so manage the horizontal rudders that the vessel shall practically maintain its level but in fact its course becomes really an undulating one up and down There must be no movements of men or weights in the vessel without immediate compensation to restore and maintain the balance else the submarine may dive to a disastrous depth Manual has been found better than automatic control

Locomotives Indicating National Character —An ingenious French study of the various types of locomotives in use throughout the word undertaken from a new point of view presents some interesting conclusions One of the most surprising inferences drawn was that genuine art is exhibited in the construction of locomotives They show it is contended from the French standpoint, beauty of line and proportion and true originality of treatment The American locomotive combines elegance practicality convenience and power thus betokening qualities of the race that does its work well The English locomotive it is stated is more trim and snug being smaller but without loss of power The French is lighter and finer in line than either of the two mentioned but is less powerful and effective

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GOODWIN'S MODEL MONOPLANE EXHIBITED AT OLYMPIA

This kite shaped double-surface monoplane has its motor between the surfaces. The propeller turns in a slit as shown

Third International Aero Exhibition at Olympia 1911*

THE EXHIBITS ANALYZED

The Olympia Aero Show has unquestionably realized all anticipations of exceptional interest. It is true that the exhibits might have been more numerous, but there were after all twenty different machines on view, ten of which were monoplanes and ten biplanes—which fact in itself is additionally interesting as indicating the balance of opinion that exists at the present time as to the relative merits of the two types. Each type has of course its own particular advantages, which are emphasized or deprecated by individual designers according to their own personal view of what problems are most in need of immediate solution.

At the present show the keynote in design is struck by the prevalence of inclosed bodies, a feature that characterizes the majority of the machines present, and is of itself of the greatest interest and importance. At one time constructors used to be very particular about adopting stream line form for struts and other small members, but practical considerations soon showed that this refinement scarcely warranted—by any increase in efficiency that it afforded—more attention than could be conveniently bestowed upon it in the ordinary course of construction. If struts and spars could conveniently be made of stream line form without undue extra expense, all well and good; if

* Reprinted from *Flight*

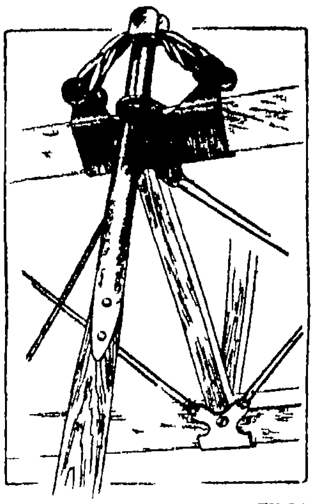
A COMBINED SUBMARINE AND MONOPLANE

This freak model gives an interesting hint of what the future aeroplanes may accomplish

The Valkyrie monoplane in the center foreground. The cigar-shaped Piggott monoplane is at the right in the middle distance. Capt. Cody's huge biplane is shown at the extreme right

GENERAL VIEW OF THE AERO AND MOTOR EXHIBITION AT OLYMPIA

on the other hand it was more convenient to make them rectangular then some leading firms at least made no bones about ignoring the purely scientific side of the problem. As a matter of fact, moreover this elaborate application of pure theory to practice is very apt to ignore practical considerations that are not taken into account in the theoretical hypothesis.



Flight

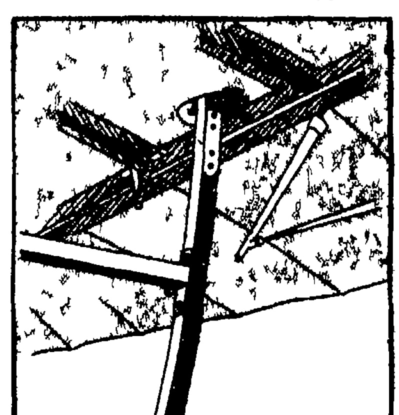
SKETCH ILLUSTRATING THE CRUTCH SUSPENSION OF THE BRISTOL MONOPLANE

For instance aeroplanes nowadays no longer only fly in the calm and indeed the art of aviation has progressed to an extent sufficient to enable pilots to navigate the atmosphere when the wind is blowing at a velocity that represents numerically a fairly high percentage of their own flight speeds. If therefore the wind is not blowing in the line of flight the axes of stream line forms on the machine will be more or less athwart the relative wind and much of the advantage of the special shape will thus be set at nought. While this argument holds good in connection with the struts and other members that are relatively small compared with the machine as a whole it does not necessarily apply with equal force to the question of inclosing the whole of the principal masses in a casing of stream line form. The engine and the pilot offer a very considerable extent of surface that does nothing but oppose the flight of the machine by the resistance of the normal air pressure upon it.

Clearly this is neither the time nor place to deal with the mathematical and technical aspects of this most important subject but suffice it to say that as far as theory is able to indicate at the present time the use of stream line casings offers every opportunity for effecting an important saving. Hitherto of course it has been of less moment to pay very much attention to this matter as other more pressing considerations have called for immediate notice but with the general tendency toward increase in speed—and incidentally in fact that high speed is of first importance in the prospect of winning the *Daily Mail* $50 000 prize—the question of body resistance becomes one of fundamental importance. The inclosing of the engine and pilot in a stream line casing is moreover an altogether different matter from the mere shaping of individual struts.

At Olympia this year the stream line bodies are the predominating feature in design. In the degrees of completeness they range all the way from the new Piggott monoplane which has every part of the body the engine pilot and passenger completely inclosed in a large torpedo-shaped casing with a hemispherical head. This represents the extreme development of the stream line idea, and it will be interesting to watch how far this whole-hearted adoption of a good principle works out in practice. Generally speaking such things are best evolved by degrees, and we do not doubt that it will be necessary to cut a few more holes in the Piggott shell before it satisfies the requirements of the average pilot. It will at any rate, take, we should imagine, some little time to get used to being completely boxed in for even as it is, with orthodox machines, aviators often complain of impeded vision. On the Piggott machine the outlook is entirely through windows made of insoluble gelatine and the passenger and the engine are both situated in front of the pilot. The propeller boss which is conical forms a revolving pointed nose on the otherwise hemispherical head of the body.

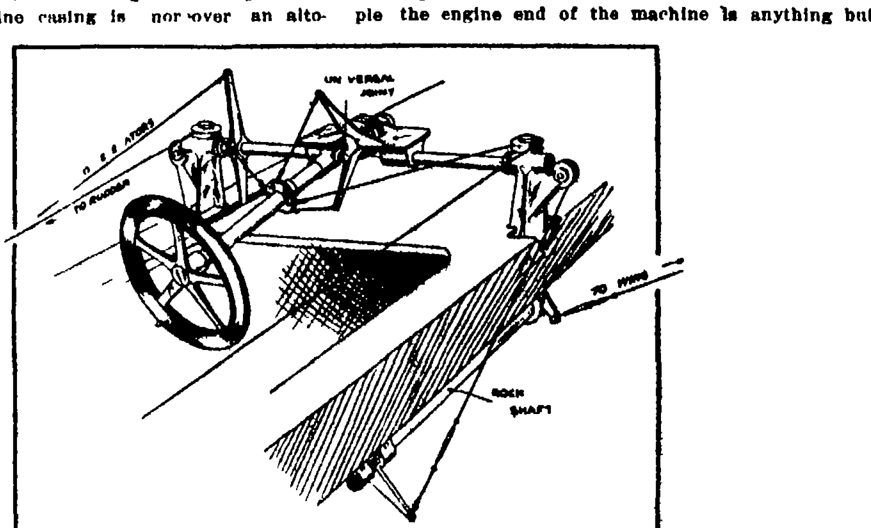
An almost equally pronounced example of inclosed body work is given by the Kny aeroplane constructed by Messrs Mulliner of London and Northampton but in this machine the body is boat-like in form and the pilot and passenger can have at any rate, nothing but sky above them if they care to detach the coaming tower cover plate. Like the Piggott the stream line body of the Kny aeroplane extends to the tail and the latter part of it is fabric-covered. In front, the outer surfacing material is sheet aluminium. On the Piggott machine the surfacing material is entirely fabric. Fabric is also used for enclosing the framework of the Nieuport monoplane, for which Maurice Ducrocq has the agency. In this machine however the rectangular section of the main frame has not been inclosed by any supplementary casing as on the Piggott monoplane and consequently the sides of the body are flat. In appearance, however the Nieuport monoplane distinctly belongs to the class under consideration although possibly its right to such classification is based more on appearance than



Flight

SKETCH SHOWING THE ARRANGEMENT OF THE FRAMEWORK AT THE TAIL OF THE HOWARD WRIGHT MACHINE

actual design for there is little doubt that the small size of the horizontal twin-cylinder engine in front considerably enhances the stream line appearance of the body which if fitted with a more conventional motor might call for less comment on account of its shape. In the Handley Page monoplane for example the engine end of the machine is anything but stream line like in form yet there is no better example of stream-line construction at the Show than is provided by the after-part of its body. It has quite a fish like appearance and is surfaced throughout in highly-polished three-ply mahogany. As the machine is only designed to carry the pilot, its general lines are characterised by short overall length, and so this particular machine has an uncommonly neat appearance.



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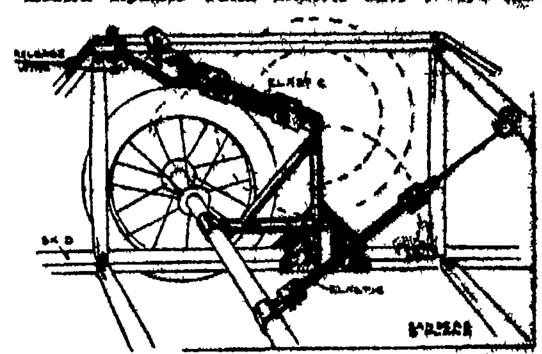
SKETCH ILLUSTRATING THE CONTROL ON THE BLACKBURN MONOPLANE

More conventional examples of inclosed body work in which the surface material is simply laid on the frame are [illegible] the Blériot, Martin-Handasyde, Bristol and [illegible] monoplanes, and, strictly speaking, it is to this latter category that the Nieuport also belongs.

The most interesting development of inclosed body work is, however, in connection with some of the modern biplanes which hitherto have always been



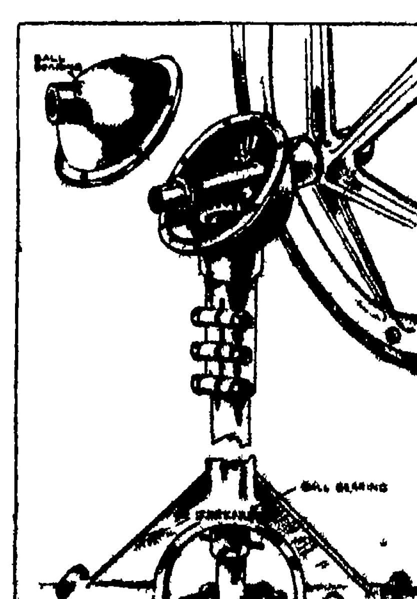
Flight

SKETCH ILLUSTRATING THE MECHANISM OF THE DISAPPEARING AXLE ON THE SANDERS BIPLANE

By releasing a catch the axle and wheels are drawn above the level of the skids, on which latter members the machine can therefore land direct.

characterised by the entire exposure of all the principal masses. The most important—as it was also one of the earliest examples of this system of construction—is the Breguet biplane which may be described as having a monoplane body supporting biplane wings. The body is completely surfaced from head to tail and is of great length. Unfortunately it has a most ungainly appearance, owing to a peculiar discontinuity in its lines but this is perhaps, more pronounced when the pilot is not on board, because the general shape has been based on the aviator's position in the machine and on the amount that his body projects above the level of the frame. A new type of Bristol biplane which is now being built in addition to the Farman pattern is designed on Breguet lines and has the characteristic inclosed body which with the single row of struts in the gap and the engine in front, constitute the outstanding features of the Breguet type.

Various other applications of this principle of inclosed body work to biplane construction are to be found among the modern examples of the Farman type of aeroplane. The Bristol machine of this pattern made by the British and Colonial Aeroplane Co has a kind of car for the pilot and passenger but the engine being a rotary Gnome is exposed. On the genuine Maurice Farman exhibited by the Aeroplane Supply Company a similar casing extends around the engine also which in this case is a stationary Renault, with the propeller mounted on the half-speed cam-shaft. On the Grahame-White biplane the pilot and passenger sit in a dainty little gondola



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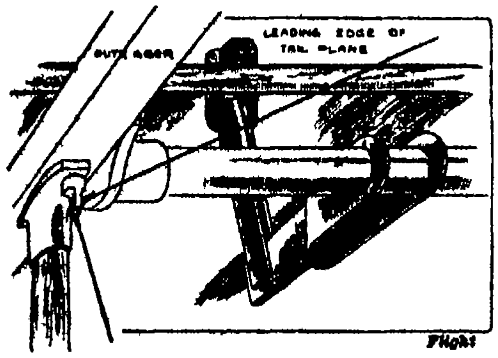
THE MARTIN HANDASYDE CONTROL GEAR

On the Howard Wright the aviator carrying the foot-rest is [illegible], and [illegible] of tray, but otherwise everything is exposed as in the original design.

Turning to a consideration of the [illegible] of

[illegible] from the point of view of their general [illegible], it is interesting to compare them by classification into broader and somewhat more fundamental divisions than results from a mere discussion as to whether they are in the latest mode as regards body construction There are twenty machines on view [illegible] of which are biplanes and ten monoplanes Of the ten biplanes five may properly be classified as belonging to the Farman type These include the British built copies by the British and Colonial Aeroplane Company Messrs Howard Wright and Messrs Grahame-White Each has minor peculiarities of its



SKETCH ILLUSTRATING HOW THE ATTITUDE OF THE TAIL IS ADJUSTED BY A HAND WHEEL ON THE SOMMER TYPE HUMBER BIPLANE

own There is also the Maurice Farman which differs from the Henry Farman in the flatter appearance of its planes and in the extended skids, which curve up to support the elevator on the Sommer principle The Sommer type which may be practically considered as a modification of the Farman design is represented at Olympia by the Humber biplane The essential characteristics of the Farman machine which is unquestionably the most popular aeroplane that has yet been built are basically that of the original Voisin from which it was evolved by Henry Farman who flew the Voisin biplane at a time when he was one of the first men to fly at all The Farman machine is a biplane with an elevator in front a tail behind and the propeller immediately behind the main planes As the popular type of engine used on this machine is the Gnome rotary which is always mounted adjacent to the propeller the principal mass is situated aft of the center of pressure and consequently the tail is necessarily of the lifting type because the pilot does not in the accepted position balance the engine by his own weight

On the Breguet biplane where the relative positions of the engine and pilot are reversed the tail becomes practically speaking a non lifting member although in actual practice the tail of the Breguet is a slightly cambered plane Incidentally of course the Breguet system facilitates the use of a monoplane type body because the propeller being in front does not interfere with the continuity of the longitudinal spars in the construction of such a member The inclosing of the body so as to be more or less of stream line form which feature has already been discussed is of course only a natural evolution as the outcome of taking a further step in detail design While on the subject of the Breguet machine it should also be mentioned that quite apart from the question of type this model belongs to a class apart in any case, because it is constructed entirely of steel—timber being now as formerly, the standard material for aeroplane framework. The Bristol-type aeroplane made by the British and Colonial Aeroplane Company is constructed of wood.

Of the three remaining biplanes at Olympia, each belongs to a separate class There is the small Wright racer, with which type Mr Alec Ogilvie competed in the Gordon Bennett race the Cody biplane with which Mr S F Cody won the British Michelin Cup and the Sanders biplane which in some essential features resembles the biplane originally designed by Messrs. Short Brothers.

The Wright biplane in its present form is characterized by the absence of any front elevator and by the use of a non lifting tail Practically the machine is in balance about the center of pressure with the pilot on board and indeed the spiral draught from the propellers is enough to upset this balance through its influence on the tail plane

The Cody biplane is similarly a balanced machine but it differs from the present Wright type in having an elevator The elevator on the Cody machine is a cambered plane and normally carries some of the load for convenience in control although it is not essential from constructional considerations that it should do so The engine on the Cody biplane is carried on the lower plane and within reason both it and the pilot can have their positions altered in order to effect any degree of balance that may be required In practice as has been mentioned Mr Cody prefers that the elevator should be loaded a little as he considers that it facilitates control

The Sanders aeroplane is fundamentally a modification of the original Wright biplane as its only tail member is the rudder and there is an elevator in front This elevator however probably carries proportionately more load than on the original Wright because the very strong Short type girder under carriage is probably heavier than the corresponding outrigger on the original Wright machine These girder skids and the elevator shaft itself are to all intents and purposes the same as those on the Short biplane last year The main planes themselves are characterized by sharply downturned extremities on the upper plane that act as side curtains to prevent leakage and sideslip The engine and propeller on the Sanders biplane are arranged more or less on the same lines as the Cody—that is to say the propeller is mounted midway in the gap and is driven at half engine speed by a single vertical chain The rudder is a triplane in which respect it differs from the biplane rudder on the Wright

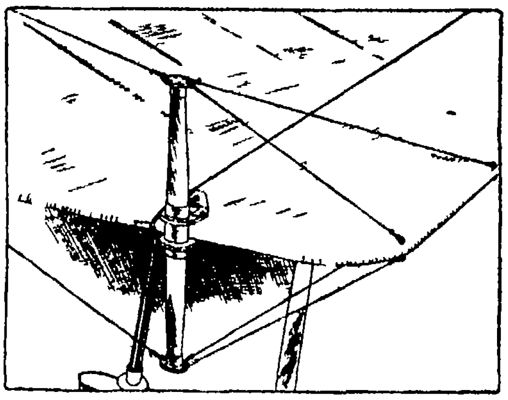
If we attempt to compare the monoplanes on a similar basis it is somewhat more difficult to differentiate between types owing mainly to the gradual merging of the characteristics of the Blériot and Antoinette patterns that have hitherto led the field and been distinct Thus for instance the V section boatlike Antoinette body may be seen combined with Blériot pattern wings which are certainly quite distinct from the planes of the true Antoinette both on account of the fact that they are thinner and also by reason of the absence of individual trussing on the wing spars

A genuine Blériot with its characteristic lifting tail rectangular open girder body and rather low set center of gravity is exhibited by the London representatives of that firm while the Martin Handasyde monoplane may be considered at any rate as regards its appearance as characteristic of the real Antoinette It has the triangular section covered frame, non lifting tail and individually trussed wing spars. As a design however the Martin Handasyde monoplane is full of original detail

Machines like the Blackburn and Bristol monoplanes may be classified as lying between these two distinct types inasmuch as they have Antoinette bodies with wings that certainly bear more resemblance to the Blériot pattern than the Antoinette and are at any rate, trussed only to one central mast.

In the Kny, Piggott, Handley Page and Nieuport monoplanes the body form predominates over all other characteristics but in the principle of the non lifting tail they are alike The Kny has its wing spars individually trussed more or less on the Antoinette principle but in the other machines mentioned the wing spars are not thus reinforced

Properly speaking the real distinction in monoplanes of this classification should be drawn between the tail behind and tail first types and in the latter category the Valkyrie is at present the only example on view This machine is of essentially British design and construction It is characterized by a fixed load

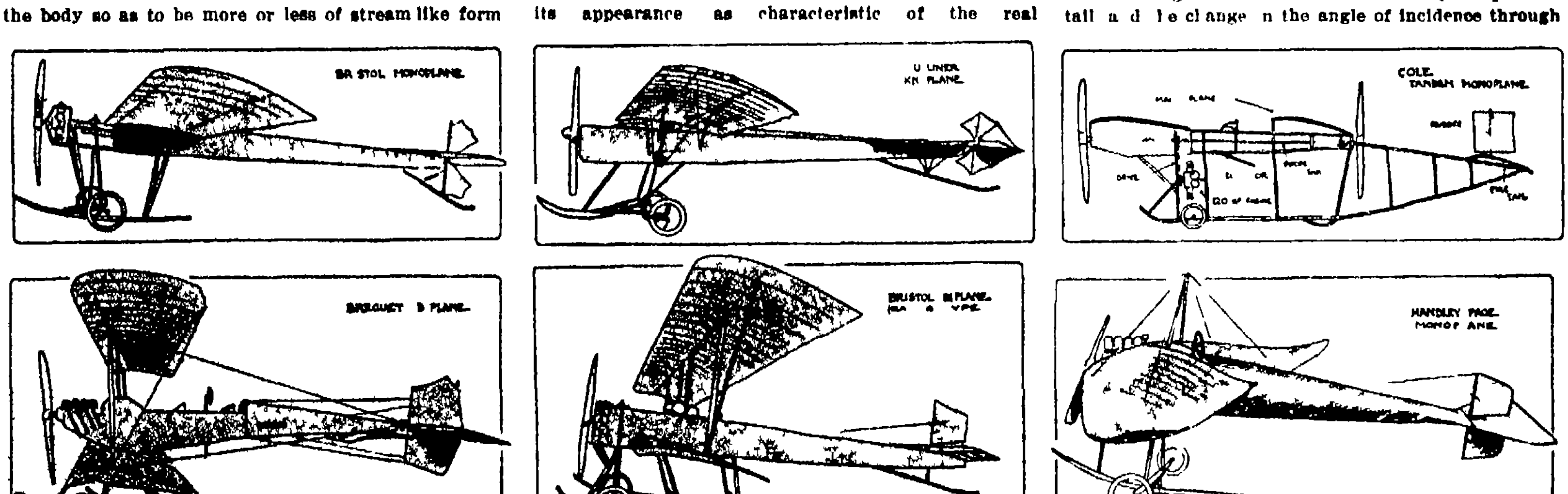


DETAIL SKETCH ILLUSTRATING THE REAR ELEVATING PLANE ON THE FARMAN BIPLANE

carrying leading plane in front of the main plane which leading plane must not be confused with the movable elevator that is also provided In the Valkyrie machine the propeller engine and pilot are likewise all in front of the main plane In the Antoinette monoplane the engine and propeller are both appreciably in front of the main plane and on the Blériot monoplane the engine and propeller are still in front but distinctly closer to the leading edge Inasmuch as the central portion of the Valkyrie main plane is recessed to take the propeller the engine—supposing it to be a Gnome rotary—is not really so much further forward of the leading edge proper than it is on the Antoinette and thus the essential distinction is more or less confined to the change in the position of the pilot Appearances are therefore apt to be a little deceptive in respect to the relative distribution of weight with this particular design

A monoplane that is altogether in a class by itself is the Dunne which is so far as practical flying machines are concerned an evolution of the Dunne biplane The biplane was in itself however originally evolved from still earlier monoplane models A characteristic feature of this machine is the absence of a tail and the V plan form of the wings which also have a varying angle of incidence from root to tip The object of the design is the acquisition of natural stability and the purpose of sloping back the wings is to acquire an overall length for the machine as distinct from the chord dimension This increment in length virtually introduces the principle of a tail and the change in the angle of incidence through out the succeeding sections of the wings confers the principle of the dihedral angle on the relative attitude of the virtual tail portion in respect to the central leading portion of the machine

In fundamental principle the Valkyrie appears to be not dissimilar to the Dunne although there is no structural likeness whatever The leading plane in the Valkyrie however may be likened to the central portion of the Dunne machine and it makes a dihedral angle in respect to the main plane the extremities of which correspond to the rearward tips of the Dunne wings This comparison is, perhaps not altogether



VARIOUS TYPES EXHIBITED AT OLYMPIA

Drawings reproduced from Flight

on I sive as th s br efly drawn but it has been made with I e object of empl asizing that it is in the under lying principle rather than in the form of the machine that types should be compared on a common scientific basis The Handley Page monoplane for example has c s oped back wings arranged with a crescent form of leading edge and the dihedral angle is present in a minor degree by the use of upturned flex b e wing tips Apart from the shape of its wings however the Dunne monoplane is characterized by its underhung load the engine and pilot being situated beneath the wings. In the Sanders biplane which in this respect represents the principle of the early Wright flyer the elevator may be regarded as a for ward tail b t as its attitude can be varied at will s ability is dependent on the action of the pilot

Thus far we have discussed the machines that are already familiar to readers of *Flight* and indeed it is one of the most satisfactory features of the present exhibition that so much of the display is admittedly within the realm of successful practice No one can possibly say that the present exhibition lacks orig inality in aeroplane design and yet it is singularly free from freaks Practically the only purely specu lative designs are the tandem monoplane exhibited by Messrs William Cole and the machine exhibited by Mr F J Bartelt Of these the former is unfin ished and is thus possibly in some degree exempt from criticism, so we would therefore confine our selves to saying that it labors under the disadvantage of having an unprepossessing appearance The design is due to a Frenchman, M Magnodex and attacks a particularly interesting problem in aeroplane con struction The tandem monoplane was on the point of being the first machine to fly in America when Langley was tripped up by ill-fortune in his endeavor to demonstrate a full sized machine of this type before representatives of the American Government. Langley had succeeded in obtaining very successful flights with large power-driven models, and his construction of a man-carrying aeroplane was undertaken at the insti gation of the American Government, as a direct out come of his previous work Faulty launching ways twice brought about temporary disaster to the machine, and the authorities having little faith in those days withdrew their support. Within a few weeks the Wright Brothers had secretly succeeded where Langley failed and in the evolution of their machine the tandem monoplane has been forgotten

The necessity for overall length on a machine as a factor in its stability and the necessity for pro viding an adequate body in order to carry the tail certainly suggest the possibility of developing a useful type in the tandem monoplane since it plausibly [illegible] lifting surface for the [illegible] Whether or no the Cole machine will [illegible] modern prototype of this class we should not like to say In its present form it certainly seems to be following an undesirable principle in attempting to combine such unknown quantities as a tandem monoplane wooden folding wings, twin propellers, and a new type of rotary engine on the same machine

The Bartelt machine is something apart from all accepted types. It consists of a steel structure of biplane appearance with loose, saggy wing surfaces. The wings are mounted at their shoulders on cranks, whereby they rise and fall, while always remaining parallel to the ground. The motion of the cranks being circular the wings, simultaneously with their rise and fall move forwards and backwards—in other words they perform a modified form of paddle action, the object being to derive support by beating the air The wing motion is obtained from chain transmission, and in addition to the supporting reaction, there is said to be a propelling force sufficient to keep the machine going without the small propeller that is such a comparatively insignificant constructional fea ture of the machine as a whole. We are informed that the small scale prototype of the machine exhib ited actually flew with a pilot weighing 8 stone 4 lbs.

The Air-brake as Related to Progress in Locomotion—III*

The History of a Great Invention

By Walter V Turner, Chief Engineer, Westinghouse Air Brake Co, Pittsburg, Pa.

Continued from Supplement No 1841 page 230

To CONSIDER for a moment the quantitative results of the improvements which have been mentioned as evidenced by the comparative stopping distances of trains equipped with the types of brakes referred to The diagram (Fig 18) shows concretely the relative efficiency of the vario is forms of brakes for passenger trains the difference in the length of the lines cor responding approximately to the reduction of distan e required in which to stop a given train of one loco motive and six cars from a speed of 60 miles per hour since the introduction of the air brake If the dia gram were inverted so that it is viewed ipside down a fair idea will be obtained of what the relation between the stops wo ild have been through the re spective periods of train development had there been no change in the air brake since first applied

The tendency of modern rolling stock to lower brake efficiency is further illustrated in Fig 19 The

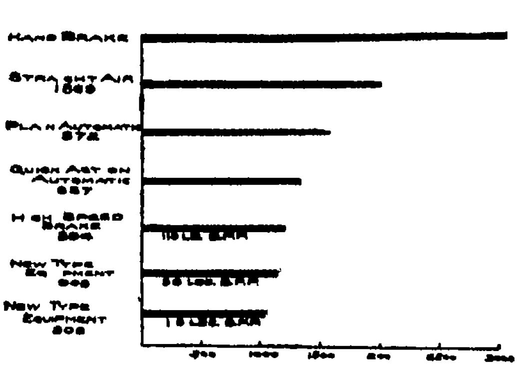


Fig 18—DIAGRAM OF DEVELOPMENT OF AIR BRAKE EFFICIENCY SINCE 1869

retardation curves show the stopping distance from al o t the same initial speed of a train composed of cars weighing 30 000 pounds and braking at 88 per cent and a train of 84 000 pound cars braking at 150 per cent It will be seen that notwithstanding the 60 per cent greater braking power of the heavier train the difference in stop is not greatly in its favor The reason for this is clear when it is considered that the work done during the stop for the light train was 14 foot tons per brake-shoe per second while with the heavy train it was 29 foot tons per brake-shoe per second which shows that under modern con ditions each brake shoe is doing about twice the amount of work required formerly in order to make approximately the same stop which consequently low ered the coefficient of friction and thus tended to equalize the actual retarding forces developed in the two cases

The diagram below the comparative curves shows first the length of stop for light train with the equip ment of its day second what the stop would have been with the heavier train had there been no change in brake equipment to correspond to the increased weight of train third what braking power was actually required to stop the heavy train in the dis tance the light train was stopped with its brake equip ment and fourth what the stop of the light train would be if it were possible to apply to it the brake equipment required for the heavy train This is a significant and all-sufficient example of what is re quired to meet modern conditions as effectively as they were provided for in the past.

CONTROL VALVE EQUIPMENT

With the introduction of heavy sleeping cars and passenger equipment cars carrying heavy motive power apparatus such as self-contained motor cars, not only were the factors above mentioned, which tend to lower brake efficiency aggravated to a marked degree, but limiting conditions were encountered in other directions. The brake force required to control such heavy (155,000 to 170,000 pounds) cars with approximately the same effectiveness [illegible]

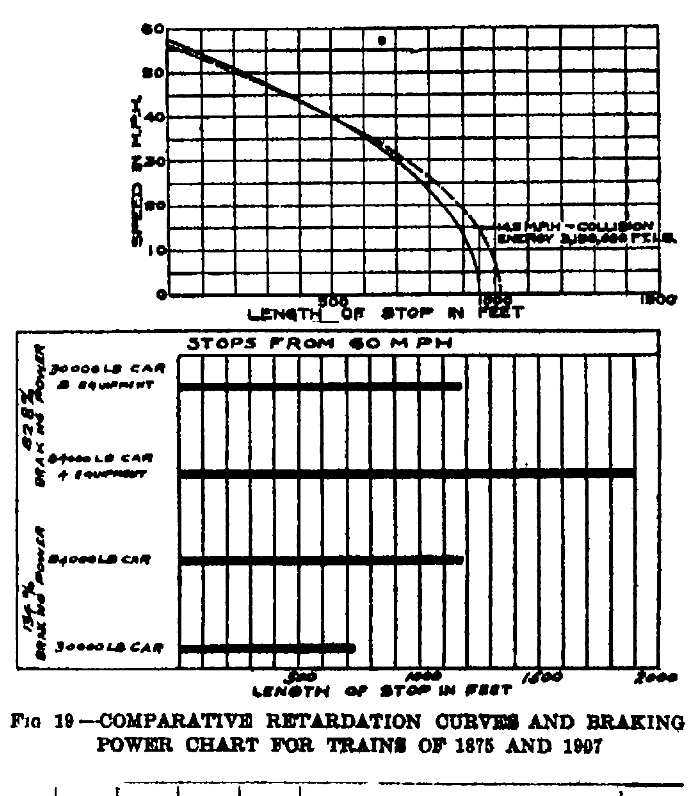


Fig 19—COMPARATIVE RETARDATION CURVES AND BRAKING POWER CHART FOR TRAINS OF 1875 AND 1907

Date	Speed in M P H	Lgth. of stop in feet	Time of stop in sec	Wght of trains, tons	Work in ft tons performed by brakes			B P p c
					Total	Per sec.	Per brake-shoe per sec	
1875	56 0	1080	[illegible] 0	297	[illegible]	1080 4	14.70	[illegible]
1907	67 3	964	18 7	559	61800	3878 9	28 75	150.0

Dotted curve shows stop on Midland Railway 1875, with the Westinghouse Automatic Brake.

Full line curve shows stop made on W J and S. R. R. 1907 with the Westinghouse "LN" Brake.

Had the braking power as shown in the last column of the table and represented by the full-line curve, been 134 per cent instead of 150 per cent, the two stops would have been the same.

* Presented at the meeting of the Mechanical and Engraving Section of the Franklin Institute.

[illegible] with the highest brake-cylinder pressure and greatest multiplication of its power by leverage that could be permitted

The single brake-cylinder had already reached a maximum of 16 inches in diameter and it was generally agreed that a larger size brake-cylinder would be impracticable from a manufacturing, operative and maintenance standpoint.

With 100 to 105 pounds brake-cylinder pressure being obtained from 110 pounds brake-pipe pressure carried there was little hope of raising the cylinder pressure higher and no materal or permanent improvement in the general condition would result even if the full 110 pounds could be realised in the brake-cylinders.

There was no suggestion of an increase in brake-pipe pressure above the present standard it being universally recognized that 110 pounds was about as high as could safely and economically be used with the type of apparatus and fixtures in general service.

The multiplication of the brake-cylinder pressure through the leverage of the foundation brake rigging had been carried in many cases beyond the recommended 9 to 1 maximum simply because it was the most obvious, simplest, and most convenient means of providing the heaviest cars with a proportionate braking power approaching that used on lighter cars The evils of this expedient soon became manifest in dragging brake-shoes slow release and trouble in keeping the brake rigging properly adjusted Most important of all from a safety standpoint, was the effect of this high leverage ratio in multiplying the losses due to lost motion in the rigging or truck members, brake-shoe movement and so on the result of which was evidenced in excessive false piston travel and consequent failure to obtain the maximum brake-cylinder pressure contemplated in the design or still more serious loss in braking power due to the piston traveling so far as to bottom on the cylinder head

These and other mechanical limitations therefore barred further progress in this direction and two alternatives remained viz

1 To increase the effectiveness of the single brake-cylinder as far as possible by using two brake-shoes per wheel (clasp brake)

2 To use two brake-cylinders per car

While the first of these alternatives would undoubtedly be of some assistance there are objections to this design not the least of which is a reasonable doubt whether the acknowledged theoretical advantages of the clasp brake would prove to be practicable and a reasonable certainty that no matter to what extent its theoretical advantages might be realised in practice the maximum increase in efficiency thus afforded could not be sufficient to meet the demands of donditions already existing to say nothing of the possibilities of the future

On the other hand the two-brake-cylinder proposition did not necessarily involve any new or untried principles since two complete equipments of the type already in service might be used one for each end of the car This would provide ample stopping power for existing conditions and lend itself readily to extension as still more severe demands might arise. It was therefore recognized that such an arrangement offered the best solution of the problem of the proper air-brake equipment for passenger cars weighing 130 000 pounds or over Furthermore it was seen that a single valve mechanism to control the admission of air to and release of air from the two-brake-cylinders would possess such marked advantages over a complete double equipment for each car as to make a satisfactory and practicable design of such a valve greatly to be desired. In reality the success and scope of the two-cylinder arrangement depended wholly on the characteristics of the valve device adopted for this purpose.

It was but logical that in the first practical solution [illegible] at the same principle [illegible] operation, as had [illegible] already in use for some years, and giving the best of satisfaction under conditions quite similar to those of the two-cylinder passenger-car equipment While this valve (the distributing valve of the "ET" locomotive brake equipment) was particularly designed to operate in connection with two or more brake-cylinders on locomotives, its distinctive operative features were equally advantageous for passenger car service Consequently when the introduction of 85-ton multiple unit electric motor cars on the N Y N H & H R R electric zone called for a correspondingly effective form of brake apparatus of necessity using two-brake cylinders the valve mechanism adopted was a modification of the distributing valve type the changes being only such as were required to adapt this device to passenger train service From the start its performance under the severe demands of suburban electric service was so satisfactory as to thoroughly establish the advantages of this type of equipment for the high braking efforts and large brake-cylinders required by the heavier classes of cars It is hardly necessary however to go further into detail regard ng its construction or operatio first because the design of its operating mechanism resembles so closely that of the distributing valve and second since it served to mark one stage only in the development of a distinct type of brake apparatus for such service

As already stated with the advent of passenger carrying cars weighing from 135 000 to 150 000 pounds in steam road service and still heavier motor cars carrying extraordinary dead weight loads the limit of an efficient single-cylinder equipment was approached and in some cases exceeded But this was only one phase of the sit ation The demand of high speed heavy train service had steadily advan ed to a point where for adequate control something more was required of a brake than merely maximum retarding power in emergency The ordinary service functions and automatic safety and protective features became hardly secondary in importance Briefly stated the requirements recognized as essential in a satisfactory brake for this modern service are as follows

1. Automatic in action

2 Efficiency not materially affected by unequal piston travel or brake-cylinder leakage

3 Prompt serial service action

4. Graduated release

5 Quick recharge and consequent ready response of brakes to any brake-pipe reduction made at any time.

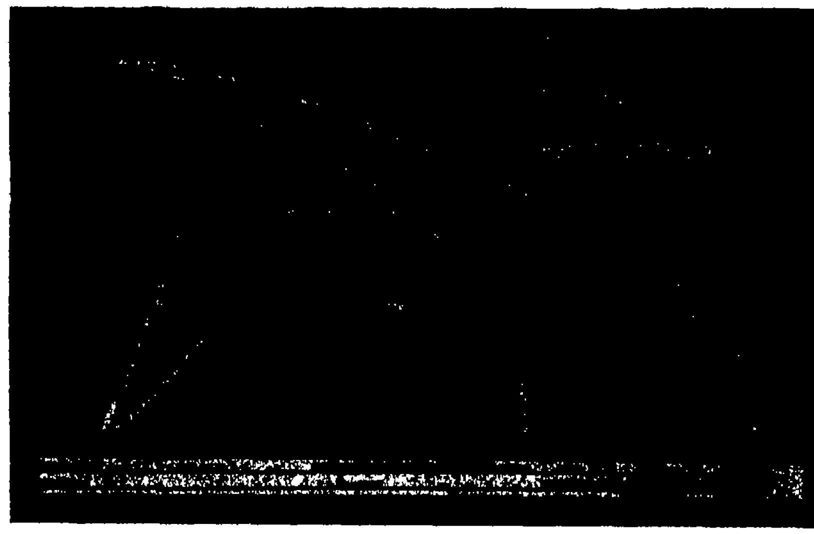
6. Predetermined and fixed flexibility for service operation.

7 Full emergency pressure obtainable at any time after a service application.

8 Full emergency pressure applied automatically after any predetermined brake-pipe reduction has been made after equalization

9 Emergency braking power approximately 100 per cent greater than the maximum obtainable in service applications

10 Maximum brake-cylinder pressure obtained in the least possible time



F G 21—COMPARATIVE TRAIN STOPS CONTROL VALVE AND HIGH SPEED BRAKE EQUIPMENT

11 Maximum brake-cylinder pressure maintained throughout the stop

12 Brake rigging designed for m ximum efficiency

13 Adaptability to all classes and conditions of service

That certain of these req irements demanded radical changes in the valve device used on the car is evident from a comparison with the functions of the previous types already referred to since but one of these required functions was contained in the older equipment These considerations led to the latest development in the art of controlling heavy high speed passenger trains employing what is known as a control valve in the place of a triple valve the fun tions of which have already been mentioned in brief The complete equipment is known as the schedule PC and is illustrated in Fig 20

The relative stopping power of the most efficient of the old order of brake apparatus the high speed brake—and of the control valve apparatus is contrasted in the curves of Fig 21 Both the comparative lengths of stop and the relative rates of rise and a nount of maxim m braking power are shown by the curves It will be noted that the 575 foot shorter stop made with the PC eq ipment resulted not only from the h gher braking power utilized but also from the quicker rate at which this braking power was built up to its maximum value As a result you will note that the speed of the high speed equipment train when passing the point (1 100-foot stake) at which the PC eq ipment train stopped was still as high as 38 miles per hour which means that 40 per cent of its initial kinetic energy (at 60 miles per hour) still remained to be dissipated (harmlessly in this case fortunately) before the train could be stopped

Moreover not only was this speed 38 miles per hour in the case of the high-speed equipment train but it passed the 1,100-foot stake six seconds before the PC equipment train reached that point That is to say the train with the "PC equipment came to a stop at the 1 100-foot stake six seconds after the train equipped with the high-speed equipment passed this

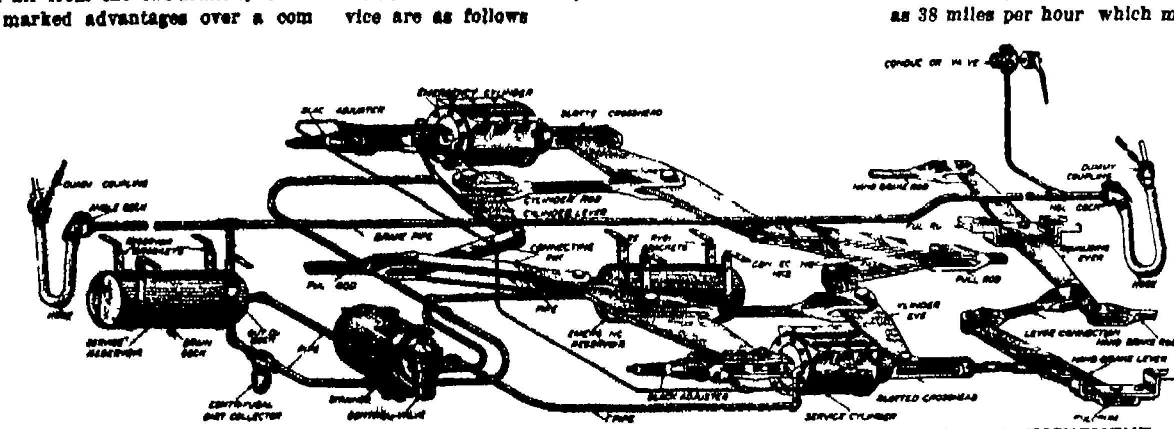


FIG. 20—IMPROVED BRAKE EQUIPMENT FOR HEAVY PASSENGER CARS CONTROL VALVE EQUIPMENT SCHEDULE "PC

point at a speed of 38 miles per hour At the time when the PC equipment train stopped at the 1 100-foot stake the train equipped with the high-speed brake equipment was 275 feet farther on and still running at a speed of 28 miles per hour which corresponds to a kinetic energy 22 per cent of the original amount when train was running at 60 miles per hour

SUMMARY OF DEVELOPMENT IN PASSENGER BRAKES

From what has gone before it will be seen that the existence and development of the passenger brake devices which have been described have come about not spontaneously of themselves or solely for them selves but in response to a definite need or for the purpose of accomplishing certain necessary and desired results the end in view always being the safeguarding of life and property and increasing the facility economy and dispatch with which larger volumes of traffic can be handled

Briefly the conditions to be overcome and the objects to be attained may be summarized as follows

CONDITIONS Increased weights of trains greatly decreasing the relative efficiency of the brake and increasing the energy to be overcome in bringing the train to a standstill Of two trains on the same number of wheels having the same nominal percentage of braking power one being twice the weight of the other the heavier train will run at least one-third further than the other

Higher running speeds increasing the energy to be overcome in making the stop in proportion to the square of the speed and adding directly to the length of stop according to the time required to obtain effective braking power on the train as a whole

Greater frequency of trains which increases the necessity for stopping quickly in a rapidly increasing ratio Not only is it of more importance than ever that the trains be readily controlled within the distances between signals but with double or four track roads there is the added greater possibility of the track on which the train is running being blocked by a break in two or other accident on the opposite track.

Increasing insistence upon the comfort and convenience of passengers and at the same time for greater economy in the handling of traffic the latter being in the nature of things antagonistic to the former without some special provision is made looking to ultimate rather than circumstantial economy

OBJECT OF IMPROVEMENTS —*In Service Applications* —(1) Much more flexible control of the train greatly reducing possibility for shocks (2) More uniform braking power reducing surging in trains and flat wheels (3) Uniform and maintained cylinder pressure notwithstanding variations in piston travel or leaky brake cylinders (4) Constantly recharged auxiliary reservoirs which increase the safety to the highest degree (5) Better protection against excessive braking power in service applications (6) Shorter smoother and more accurate stops

In Emergency Applications —(1) The human factor in the equation is reduced to a low point (2) The increased percentage of braking power and prompt rise of brake-cylinder pressure compensates in a large degree for the decrease of the retarding force due to the increased work the brake shoe now has to perform as compared with the old style brake (3) Trains can be stopped in some where near the same distance as when the cars were lighter (4 *Emergency pressure is available even after a service application has been made to an extent never before attained*

EMPTY AND LOAD BRAKES

Under modern freight traffic conditions as already stated uniformity of retardation on all cars in a train is second in importance only to safety This with mixed loads and empties hauled in the same train, is inherently unobtainable with the type of brake considered thus far It can only be accomplished by providing means whereby a relative braking force more nearly comparable to that of the empty car can be utilized on the partially or fully loaded car

The difference in braking power with the standard brake on loaded and empty cars would no doubt astonish anyone unfamiliar with the facts but can be appreciated from the statement that the same brake-cylinder pressure which gives 60 per cent braking power on an empty car will give only from 17 per cent to 20 per cent when this car is fully loaded

Four possible solutions are evident

1 *Increased Brake-cylinder Pressure for a Given Reduction and on Equalization* —In order to leave the braking power on the empties the same as at present but increase that on the loaded car to the desired amount, it would not be permissible to increase the brake pipe pressure above the 70 pounds at present generally used Even if an increase above 70 pounds *for this purpose* were permissible it would not give any higher braking power for ordinary service reductions but only afford a higher equalization pressure An increase of reservoir volume on the loaded car is therefore another alternative The maximum increase in pressure then available could not be greater than 70 pounds which while only increasing the braking power on the loaded car by 40 per cent (that is from say 20 per cent to 28 per cent braking power) at the most would destroy many fundamental and necessary features of the brake This is only about one-fifth or one-sixth of the increase required for a proper control of a car loaded to from two to four times its light weight This method is therefore impracticable

2 *Increase the Total Leverage Ratio Temporarily on the Loaded Car* —In the first place the total leverage ratio for the heavier modern freight cars and standard equipment is already so high that any such increase as required by the loaded car would be prohibitive Aside from this, however it has been demonstrated by many repeated but futile attempts that none of the various schemes thus far proposed for mechanically changing the leverage to correspond with the increase in car lading (whether automatically with an increase of car weight or manually) can be made practicable for actual road service Once established for the light car the same leverage ratio must be utilized for the loaded car

3 *A combination of increased leverage ratio and auxiliary reservoir volume* might be suggested as a possibility but it would evidently combine the objectionable features of the first and second alternatives just mentioned in such a manner as to aggravate the undesirable effects of each This method therefore fails to afford the relief sought

A fourth possibility remains viz

4 *A Second Brake-cylinder to be Added to the Ordinary Brake Cylinder to Control the Load* —A number of equipments of this type of varying form are being successfully operated on a number of railroads particularly in mountain grade service where the additional braking power thus provided is of advantage in increasing the amount of tonnage handled in a given time down the grade It will be of interest to state in outline only the characteristic features of forms which have proven successful

1 Two brake cylinders per car are used one for the empty car and both used together when the car is loaded to say two-thirds or more of its rated capacity

2 Standard leverage arrangement for the empty" brake cylinder

3. [illegible] [illegible] [illegible], [illegible], [illegible] [illegible] [illegible] [illegible] and [illegible] [illegible] cation of power from the additional "load" cylinder to the "empty" cylinder [illegible] [illegible].

4. Valve mechanism, in addition to that required by the "empty" brake, for controlling the supply of air to and from the added or "load" brake cylinder

5 Semi-automatic change-over valve mechanism for cutting the "load" brake in or out either manually or under certain circumstances, automatically

6. Additional reservoir capacity to furnish the air supply for the "load" brake.

The important problems entering into the operation of brakes on freight trains under present-day intensive traffic duty for which the "empty and load type of apparatus offers an ideal solution may be briefly as follows

1 The necessity for more braking power on loaded cars than afforded by the ordinary form of brake, in order to increase the tonnage which can be handled down long or heavy grades with safety Locomotives of such power are now built, that it is possible in some localities to haul heavier trains to the top of a grade than can be safely controlled down the other side with the standard brake

2 Trains of mixed loads and empties especially long (50 to 100 cars) trains where it is physically impossible or economically impracticable to arrange the empty and loaded cars in the train to the best advantage thus adding greately to the danger of the train parting or damage to the lading and equipment due to inequality of braking power in different parts of the train when the brake is applied at some critical speed or locality

3 Locomotives of great weight but relatively low braking power tending to increase the internal stresses in the train due to unequal retardation on different cars in the train

4 The advent of large capacity cars aggravating the differences in retardation due to lading so that the percentage of braking power on such cars when loaded is reduced to a greater extent than on cars of lower capacity for which the proportion of loaded to light weight is less

5 The requirement of operating both short and long freight trains with practically all air brakes cut in This, on a long train with loads ahead and empties on the rear end presents an operating problem difficult of solution with the old standard brake

PRINCIPLES OF TRAIN BRAKING AND BRAKE DESIGN

Throughout the foregoing description of the development of the various types of brake apparatus occasion has been taken to explain at the same time the operating conditions and service requirements responsible for their being While this has necessarily involved some reference to some of the fundamental principles underlying the proper application and operation of brakes as related to convenience economy and safety in train control there are certain limiting conditions and fixed laws which should be treated more specifically and in detail This is not so much because the present state of the air-brake art exemplifies the application of these laws and principles to the complex demands of modern freight and passenger service but rather because it is only by a careful study and sound working knowledge and appreciation of the significance of these laws that anyone is able to judge positively and accurately on the one hand the adaptability of or necessity for any new air brake device and on the other what are the requirements to which any new device or method must conform in order to adequately and efficiently satisfy the requirements of new service conditions.

(To be continued)

RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR EDWIN GOULD

1 A PRIZE of $15 000 has been offered by Mr Edwin Gould for the most perfect and practicable heavier than air flying machine designed and demonstrated in this country and equipped with two or more complete power plants (separate motors and propellers) so connected that any power plant may be operated independently or that they may be used together

CONDITIONS OF ENTRY

2 Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the Gould-SCIENTIFIC AMERICAN Prize 361 Broadway New York city Each contestant in formally entering his machine must specify its type (monoplane biplane, helicopter etc) give its principal dimensions, the number and sizes of its motors and propellers, its horse-power, fuel-carrying capacity and the nature of its steering and controlling devices.

3 Entries must be received at the office of the SCIENTIFIC AMERICAN on or before June 1st, 1911 Contests will take place July 4th 1911 and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4 The committee will consist of a representative of the SCIENTIFIC AMERICAN a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5 Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together Recording tachometers attached to the motors can probably be used to prove such performance

In the judging of the performances of the various machines, the questions of stability, ease of control, and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7 The flights will be made under reasonable conditions of weather The judges will, at their discretion, order the flights to begin at any time they may see fit provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. [illegible]

Wireless Telegraphy and Airships

A Review of Recent Experiments

By the Paris Correspondent of the Scientific American

CAPT FERRIÉ, who is at the head of the Eiffel Tower wireless station, and chief of the government wireless department, has been making experiments for some time upon the question of wireless telegraphy as applied to airships. We give the leading results of this work, which are contained in a paper presented to the Telegraphers Institution of Paris.

For wireless work in connection with airships, we require upon the airship both an antenna or aerial wire, and also a ground connection or its equivalent. We will first refer to the question of the ground wire as this is important. In Fig 1 we have the usual connections for a wireless plant as are used in various stations, and here *A* is the aerial wire and *T* the ground At *E* is the sending apparatus and *R* the receiving apparatus either of which can be connected in.

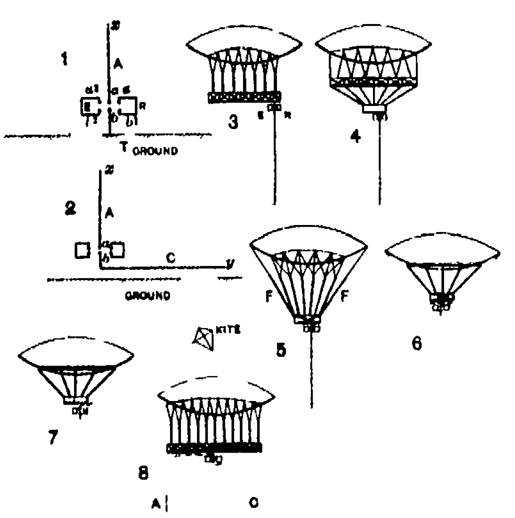
In certain cases we may obtain reasonably good results by replacing the ground wire of the aerial system by a connection with one or more insulated wires stretched above ground and equivalent to the aerial from an electrical standpoint. Such a system is known as a false ground or counter wire It can be used when a good ground connection cannot be made for instance in rocky soil In Fig 2 the ground is replaced by the false ground *C* To transmit we connect the points *a* and *b* respectively with *a*, and *b*, and for receiving with *c* and *b* It is demonstrated both by theory and by practice that while signals are being sent, the tension due to the waves is not constant over the length of the aerial or the combination of this with the false ground or counter wire This tension is greatest at the ends *x* (Fig 1) or *x* and *y* (Fig 2) At these points occur brush discharges which are stronger as the power used in the waves is greater Seeing that greater power is needed when making long distance transmission it follows that such discharges are greater in long-distance work However the brush discharges depend not only upon the energy used in the aerial but also upon the method used in producing the sparks Taking the three cases occasional sparks musical sparks and continuous wave-trains in the first two cases we store up electrical energy in condensers from which we produce a periodic spark discharge When the number of discharges is small the energy spent in each spark is evidently greater than where we have a considerable number of sparks The consequence is that the electric tension in the aerial and especially at the ends *x* or *x* and *y* (Figs. 1 and 2) is weaker as the number of sparks is greater and the brush discharges follow the same law The use of musical sparks whose number is such that the noise produced becomes a musical sound allows of greatly reducing the brush discharge With a continuous wave train we have a still greater diminution but we will not dwell upon this method as it is not yet found to give really practical uses The factor of the brush discharge is an important one in order to prevent explosion of the hydrogen of the balloon as we will further see

To install a wireless plant upon an airship we must evidently use a mounting with counter wire analogous to Fig. 2 On the other hand as it is shown that the brush discharges produced at the ends of the antenna and the counter wire will ignite the hydrogen we must reduce this discharge to a minimum and to do this we use musical sparks. Besides it is required to suppress or mask all sparks which may be formed in the air, especially in the wave-generating apparatus which may cause an explosion in the hydrogen escaping from the balloon. It is also prudent in all cases to quite avoid making a transmission when the balloon valves are opened, or when there is an accidental rent in the envelop Various dispositions for the aerial and the counter-wire are used according to the different types of balloons In all cases we generally form the aerial by a single wire from 100 to 200 meters (328 1 to 656.2 feet) in length which is hung down from the nacelle after having somewhat loaded it so as to avoid difficulty when the airship is moving. As to the counter wire system it can be planned in several different ways.

First: By using the metallic mass of the nacelle and suspension wires. However the balloon proper must be sufficiently distant from the metallic extremities of the steel suspension wires, etc., so that the electric discharges produced at these points have no risk of [illegible] the hydrogen which may come from the balloon. A distance of [illegible] meters ([illegible] feet) is sufficient [illegible] to provide any metal- [illegible] balls so as to [illegible] such [illegible] the Renard type of airship for instance we may use the mounting shown in Fig. 3 The metal parts are shown in heavy lines and the transmitting and receiving apparatus *E R* are here shown outside of the nacelle for clearness In the Gross type (German) we can proceed in an analogous manner (Fig 4) and the counter-wire system is formed by the steel work from which the nacelle is suspended together with the nacelle itself

Second If the linear dimensions of the metallic masses are not sufficient for use as a counter system we can add insulated wires suspended from the balloon body so as to lengthen the former For instance in the Parseval type (German) the counter system can be formed as Fig 5 shows and the extra metal wires *F F* make up a counter system and are quite insulated from the mass of the balloon and well away from it.

Third In airships having a metallic framework like the Zeppelin or a metallic platform as in the Republique, it would be quite imprudent to incorporate such in the wireless circuits It is preferable to make a special counter system by means of metal wires quite insulated from the metallic mass and far enough away from it to avoid any accidental contacts between the live and the dead metal during the signaling for we would give rise to sparks in the metal Moreover as even the dead metal will have oscillations set up in it by induction dangerous discharges might be produced at the pointed parts of the metal It is a good plan to section the metallic cables as much as possible by insulating pieces for the electric discharges will be weaker as the dimensions of the metal parts are less. In Fig 6 we observe such a method which could be used on the Republique type. It is also proposed to form the counter system by a metal wire which is held by a kite and this could be applied to any type of airship but the kite might hinder the proper movement of the airship In cases where we have a very long nacelle the aerial and counter system could be placed in symmetrical positions (Fig 8) at *A* and *C* both of them being insulated from the metallic mass of the nacelle Such a method has the drawback of not giving the same working range in all directions, as the waves radiated from *A* will interfere with those from *C* There will be thus a maximum range in one of the planes and a minimum in the other



DIAGRAMS OF WIRELESS WORK IN CONNECTION WITH AIRSHIPS

As regards the sparks produced by the apparatus itself at the brushes of the dynamos etc it is easy to take the needed precautions by using wire gauze protectors as we find in miners safety lamps For producing the current there is generally used an alternating current dynamo having a musical frequency which can be connected to one of the shafts by a friction clutch A 2 to 4 horse power size is sufficient in general. As to the receiving apparatus there is nothing special to note However the noise of the motor hinders the reception by means of telephones and we sometimes need to use a coherer and a register so that the apparatus becomes more complicated. It is best to keep the telephone method and use a land station which has enough power to give a loud sound in the telephones. Reception of messages by the airship is besides a secondary matter as the crew has all the needed instructions before the start, and it is not likely that any others would need to be sent while *en route* The reception on board is generally confined to some conventional signals to show when messages are received demands for repeating messages etc

In closing we will mention a few points as to the range which airship plants can reach We must distinguish two classes of range first the range at which the airship messages can be received on the ground and second the range from ground to airship The first of these is the most important It depends upon the energy of the waves and the dimensions of the aerial and counter system It thus depends on the plant which can be realized on the airship but it also varies with the lay-out of the ground plant. When this latter has a large aerial the range is evidently larger than what we have with a small antenna such as the military field posts possess The range of receiving may be very long and reach some hundred miles when we use a powerful land station The total weight of a wireless plant on board an airship varies from 200 to 450 pounds according to the method used and also according to the desired range Given the general conditions of the problem as just set forth we will mention some points about the practical results which have been accomplished It will be remembered that during the last military maneuvers in France a series of tests was carried out with the military airship Bayard-Clement with Capt Ferrié on board and operating the wireless plant Although the full data are not yet made public enough is known to give us encouragement in such work It must be remembered that we have here a trial post in which every factor is reduced size weight and power

The current for the airship post is given by a storage battery using ten cells of the automobile pattern These give 20 volts with a maximum output of about 5 amperes For producing the musical sparks using a vibration period of 250 per second there is employed a vibrator which is specially designed by Messrs Bethenod and Ferrié this being a kind of large tuning fork whose vibration is kept up by electromagnets The sparks are protected by wire gauze covering so as to avoid igniting the gas The total weight of the airship plant is 130 pounds We now have some data as to the power and range It was thought hitherto that we required to produce at least 2 kilowatts power on board the airship in order to have a range of 30 or 40 miles However it is found that signals sent from the Bayard-Clement could be very clearly heard on the ground when working at a range of 100 kilometers (62 miles) using a power below 50 watts (1/15th horse-power) and even probably very near 25 watts or but 1/20th horse-power

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Wood Pulp

Wood fiber has come into general use as a substitute for the cotton rags and other materials formerly employed in the making of paper This fiber is called pulp having taken the name which used to be given to the cotton and linen fiber when it had been prepared by maceration for spreading into sheets of paper The wood fiber used to be prepared not so many years ago by a wholly mechanical process The blocks of wood were ground or rasped [illegible] applied obliquely to the grain The length of fiber depended partly upon the angle at which the [illegible] was held during this process

In place of the old mode of obtaining [illegible] chemical treatment of the wood is now in vogue As formerly the bark is stripped from the wood to secure fibers of uniform quality All discolored or decayed parts are removed for the same reason Then the wood is cut across the grain into thin chips which are carried to the top of the mill and dropped into large drums about fourteen feet in diameter and twenty four feet long

The drums are made strong enough to bear a pressure of from seventy five to two hundred pounds to the square inch When a drum is packed full of chips it is filled with sulphuric acid and other chemicals The wood is converted into a cotton like product which is then pressed dry and mashed It is next mixed with water rolled flat and cut into shape for bundling In this condition it is said to be made up of sixty per cent moisture and forty per cent fiber In this shape it goes to the paper mill Generally speaking it is found better to pay the freight on the contained water than to cheapen the cost of transportation by pressing out the water for the pulp packs hard when it is dry

One cord of spruce wood is estimated to make twelve hundred pounds of dry fiber

The Bruceton Experimental Mine*

Its Plan and Purpose

By George S Rice, Chief Engineer Bureau of Mines

The explosibility of coal dust in air having been successfully demonstrated in the 100-foot gallery of the United States Bureau of Mines at Pittsburg and in the longer galleries at Lievin France and Altofts England the next step in the investigation of coal dust explosions by each of the experiment stations was to determine the exact conditions under which such explosions took place When these conditions were understood tests of various preventive measures could be undertaken with some degree of precision Prevention or at least limitation of explosions in mines was of course the real objective of the stations

The gallery at Lievin a short length of which was erected in 1908 was gradually lengthened to a distance of 8 0 feet the one at Altofts also erected in 1908 was about 900 feet long as originally laid out In both these galleries the limitation of strength prevents safe loading with pure coal dust for more than a distance of 400 to 500 feet on loading beyond this distance the galleries are sometimes ruptured The managements of these stations have expressed the desirability of making tests of coal dust in longer and stronger galleries since it is impossible to solve all the problems surrounding an explosive wave in the short distances now available moreover methods of limiting an explosion which were successful with a loading of coal dust for a length of 300 or 400 feet would probably not be so with a longer loading or a larger explosion

The Director of the Bureau of Mines Dr J A Holmes and his technical staff at an early date appreciated these unavoidable limitations of a surface gallery hence desired to obtain an underground gallery or mine opening which would not only enable the tests to be made on a larger scale than is possible in external galleries but in which experiments could be made under actual mining conditions. In such an underground gallery there would be no restriction as to the extent and violence resulting from explosion experiments provided a suitable location was secured Moreover the methods of limiting and preventing explosions the real objective of all such investigative work could be tried out under real mining conditions

It was foreseen that the greatest difficulties in experimenting in an underground gallery would be

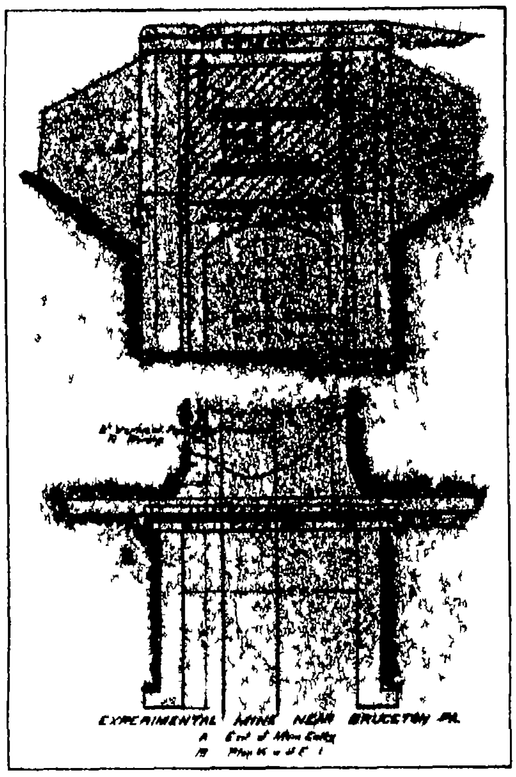
(1) To obtain certain desired natural conditions

(2) Having obtained those to carry out and control the experiments in a scientific way and be able to get complete records in the face of violent explosions

After a long search a location for the experimental gallery or mine has been selected near Bruceton Pa

From 2 500 to 3 000 feet of straight entry can be driven from the outcrop in the Pittsburg seam In some of the mines operating in the seam in the past great explosions have occurred

The entries will probably be either level or slightly rising except for irregularities so that there will be no serious problem of drainage The entries enter from a steep side hill and a cover of from 60 to 160 feet is obtained The openings are well located with reference to explosion effects as there are no houses in the vicinity except those in connection with the plant The mine is fairly close to a railroad (one third mile) so that the coal dug in advancing the entries can be loaded on railroad cars By damming a ravine close at hand water can be obtained for a boiler plant and fire protection Natural gas for experimental purposes and for use in a gas incline engine and fan engine is obtained from a pipe line which passes a few hundred feet from the mouth of the mine Finally the situation is near enough to Pittsburg to allow convenient movement of the engineers and physicists between the testing station there and the mine The location of the mine is twelve miles southwest of Pittsburg on the Wheeling division of the B & O Railroad The coal and necessary surface surrounding the mouth of the mine has been obtained at a nominal rental from the Pittsburg Coal Company



ELEVATION AND PLAN VIEW OF ENTRANCE TO EXPERIMENTAL MINE

PROGRESS AND DEVELOPMENT —After a long continued search for the best location which would give the desired conditions the present site was picked and about the middle of December permission was obtained from the Secretary of the Interior and the director to proceed with the laying out of the mine The surveys already having been made the outcrop was uncovered and two parallel entries with forty feet of pillar between them were started At the time of writing this description these entries have been driven in under cover over 200 feet The right hand one which will be considered the main entry was started in the lower part of the coal seam taking the top of the limestone which is 5 feet below the coal seams as a floor Between the limestone and the coal seam there was at this point a hard shale, the entry was excavated in this and in 3 feet of the lower part of the coal seam leaving up for a roof about 2½ feet of the main seam

After going in about 50 feet in this manner, the floor was gradually raised on an upgrade until the excavation was wholly in the coal seam and the draw slate above it The so-called "draw slate is a soft shale or clay which comes down immediately on mining the coal Above it, as is generally the case in the Pittsburg seam in this district there is 1½ to 2 feet of so-called 'roof coal," which is generally of poor quality and interspersed with layers of shale.

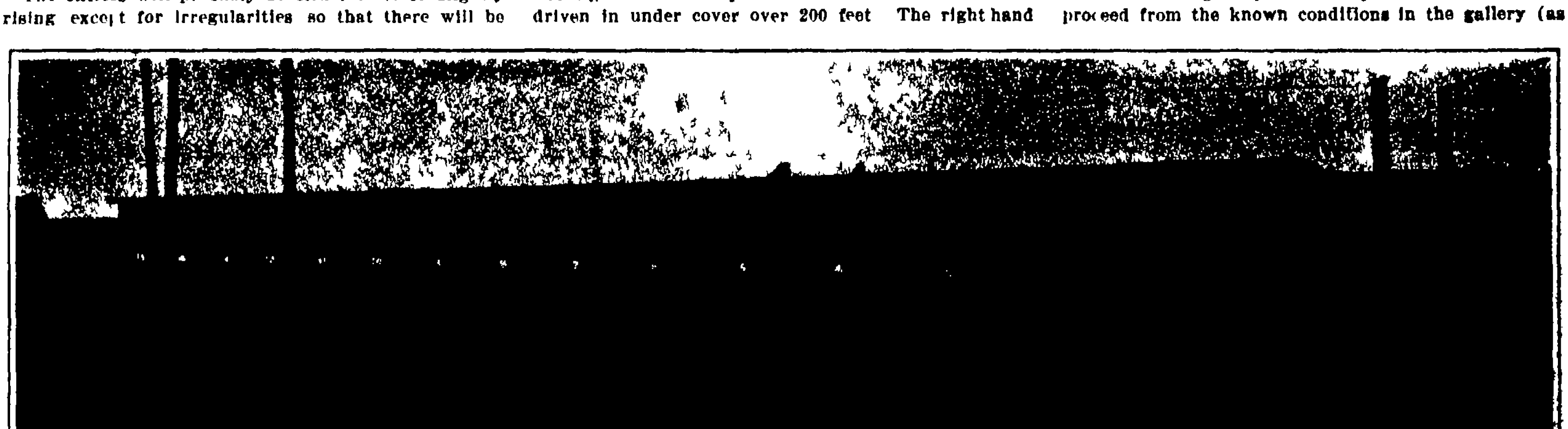
The parallel entry which will be called the air course, was driven wholly in the coal seam It is not intended to use the mouth of this entry in explosion tests. For normal driving, this air course will be the return, and ventilation will be obtained by a small fan driven by a gas engine located at the top of a small upcast shaft near the mouth of the air course This shaft will be offset from the air course about six feet

There will be another entrance to this air course joining it at about 150 feet from the mouth and entering at an angle of about fifty five degrees on the opposite side from the main inlet At the mouth of this side approach there will be placed a short length of concrete gallery with explosion doors and beyond that a round steel gallery 120 feet long 20 feet of which will consist of removable sections that can be rolled out of the way when it is desired to isolate the 100 foot gallery This part will then be identical with the 100 foot steel gallery at the Pittsburg station except in having a branch going off from it at a short distance from the inlet to which a large reversible fan will be connected The object of having this steel gallery which is 6 feet 4 inches in diameter separable from the mine is to render it possible to perform experiments similar to those conducted at Pittsburg The gallery at Pittsburg is so continuously occupied with the testing of explosives that systematic testing of coal dust cannot be undertaken in it When the removable sections before mentioned have been rolled to one side and a steel door lowered in place to cover the connection into the air course experiments can be conducted in the isolated gallery without interfering with operations in the mine

DUST TESTS IN THE MINES —At the start it is intended that coal dust explosions will be originated in the steel gallery and the explosion will enter the air course through the branch pass up same to the last open crosscut through the latter into the main entry and out to the mouth of same The crosscuts will be driven on a circle tangent to the entries This will require one forty five degree turn and one semicircular turn of the explosion wave a condition which seems to cause no obstacle in a real mine explosion nor does it cause difficulty in the Altofts gallery The records of experiments in that gallery show that on the return side that is toward the exhaust fan the dust carried by the air current and the advance compression wave of the explosion has been inflamed and the flame has passed around a number or all of the five right angled turns in that gallery

The purpose of this method of initiating explosions in the outside gallery of the experimental mine is to proceed from the known conditions in the gallery (as developed at the Pittsburg gallery) to the unknown conditions prevailing in mine entries There is also another object that while entries are being driven, it will give double the length of travel for the explosive wave and thus allow the trying out of the mathematical instruments, before passing on to the final explosion experiments which may be originated in the interior of the mine.

FIRE DAMP —Besides making investigations of the explosibility of coal dust in pure air, it is intended to make tests with small percentages of methane in

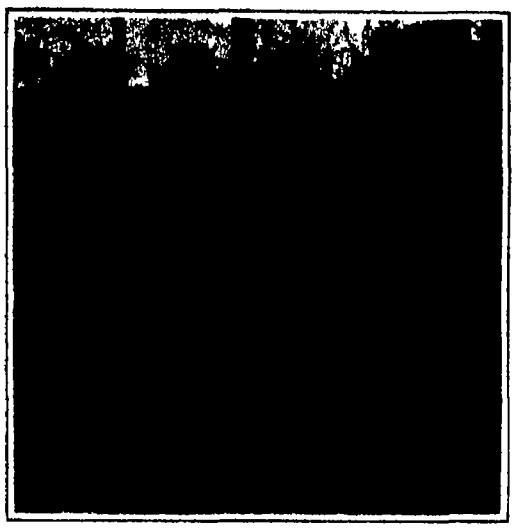


EXPLOSION CHAMBER SHOWING A SERIES OF WINDOWS AND PORTHOLES AT THE SIDE

* This paper has been prepared for West rn Society of Engineers by permission of the Director of the Bureau of Mines.

the air It is generally recognized that a very slight amount of methane, even as low as one-half per cent, may increase the chance of ignition of coal dust and more widely extend an explosion that has once been started

The location of the experimental mine is fortunate in having a natural gas-pipe line near it. This line takes gas from some gas wells in the same ravine It is intended to take a branch from this gas main for use in a gas engine hoist and in a gas engine for driving a small ventilating fan. It will also be used for



ENTRANCE TO THE EXPERIMENTAL MINE NEAR BRUCETON PA.

the purpose above indicated of introducing when desired small quantities of gas into the mine

Natural gas has very nearly the same composition as the marsh gas of the coal seams the difference being that in addition to the methane (CH_4) there is from 10 to 15 per cent of ethane (C_2H_6) This slightly varies the proportion of the mixture of air for its combustion but the difference for practical purposes is negligible

The gas will be piped to certain points and by a system of mixing with the ventilating current will be carried through in whatever proportions may be required approximate percentages will be determined through meter measurements and precise determinations by sampling the air and gas mixture and analyzing It is considered that this line of investigation of the effect of small percentages of methane is most important and the need for it has been expressed by foreign critics of coal dust experimentation now being carried on

Concrete Lining —It is anticipated that great explosive force will be developed at the mouth of the main gallery hence it is intended that the timbering which is now in place shall be supported by reinforced concrete walls and arching The latter will present a smooth surface to the explosive wave and thus prevent great falls at the mouth of the mine the occurrence of which would lead to heavy expense and delay in clearing up after each experiment.

It is the plan to concrete the approach leading from the steel gallery to the air course, and it may become necessary to concrete between this connection to the mouth of the air course, although it is not intended to load that portion of the air course with coal dust It is expected that the explosion wave entering from the gallery entrance will not have gained sufficient momentum at the junction with the air course to break down doors or stoppings erected between that point and the mouth of the air course but will be deflected into the air course toward the face

Method of Driving Entries —The method of driving entries is the usual one employed in the Pittsburg coal seam The coal is undercut and shot down with explosives which in this case are of the permissible type electrically fired The coal is loaded on pit cars which are hauled by mules to the mouth of the mine, thence over an outside tramway with slight descending grade to the head of a rope incline Trips of cars are lowered by the hoist under brake to a trestle and tipple located on a siding of the B & O Railroad

Buildings and Apparatus —It is necessary to have a considerable number of buildings these are now under construction There will be a boiler house with boiler to furnish steam for the several engines including the fan engine A crusher and grinder house will be necessary to grind up the dust for the experiments as much as four tons will be necessary when the mine is fully developed There will be a blacksmith shop containing small equipment for the necessary repairs and an engine house for the incline engine There will be a combined office and observation room for observations and the starting of explosions in connection with which there will be a small laboratory for field analyses of gas and mine air samples Several small buildings including a stable for the mules have already been constructed

Ventilating Fan —The ventilating fan for the experiments must be of such size as to create all the conditions which may surround an explosion in a mine It is desirable to obtain high velocity in restricted areas say 1 500 feet per minute over a considerable distance A capacity of 80 000 cubic feet per minute at a pressure of two inches water gage and 15 000 cubic feet per minute at a pressure of six inches water gage is specified and has been guaranteed by the builders The fan is made reversible so that experiments may be conducted with dust explosions going against the air current as well as dust explosions going with the air current The Altofts gallery fan is not reversible and the explosion portion of the gallery is at the intake end

Pressure and Recording Instruments —The important objects of the experiments are to obtain the speed of the explosion as indicated both by pressure and by flame the variation in pressures at different points along the course of the explosion the temperatures and the samples of the gases immediately preceding the inflammation of the dust or gas and immediately following the inflammation at a given point Such experiments will require apparatus of an extremely sensitive nature

A set similar to those used in the Altofts gallery has been purchased from the Cambridge Scientific Instrument Company of England These were designed primarily for external galleries but it is believed there will be no serious difficulty in arranging them in steel plate boxes sunk into the coal rib It may be found necessary to design new and additional apparatus

An important point in the use of the recording instruments is their driving also the making and breaking of electric circuits To connect these instruments with the outside will require the wiring to be done in such a way that it will not be torn out by the explosions It is proposed to place the wiring in pipes placed in a groove in the coal rib and at the mouth of the mine these pipes will be set in concrete but arranged with suitable boxes at short distances apart, so that the wires may be readily accessible.

It is evident that to make the wires safe under the enormous pressures which are expected which may run up to several hundred pounds or more per square inch will need great care To obtain the currents for the instruments will require a very steady running generator engine set It is expected to obtain a set which will be sufficiently large to allow some lighting with incandescent lamps in and around the mine

Limiting or Preventing Explosions —The real importance of the experiments is not the mere study of explosion waves although of great scientific interest,

BOY MINER AND HIS MULE WHO WERE SAVED TOGETHER FROM A MINE EXPLOSION

but to study methods for preventing or limiting explosions It is therefore proposed to experiment with all the important methods that have been suggested up to date among which may be briefly recited watering by water sprays by exhaust steam sprays and by deliquescent salts (Calcium chloride) and by rock and shale dust in various ways It is believed those experiments tried out in a mine on a sufficiently large scale can effectually demonstrate the relative efficiency of the various methods

Explosives A secondary purpose of the experimental mine and by no means an unimportant one is the study of explosives which have been placed on the permissible list for use in gaseous and dusty coal mines—testing them under actual working conditions in coal

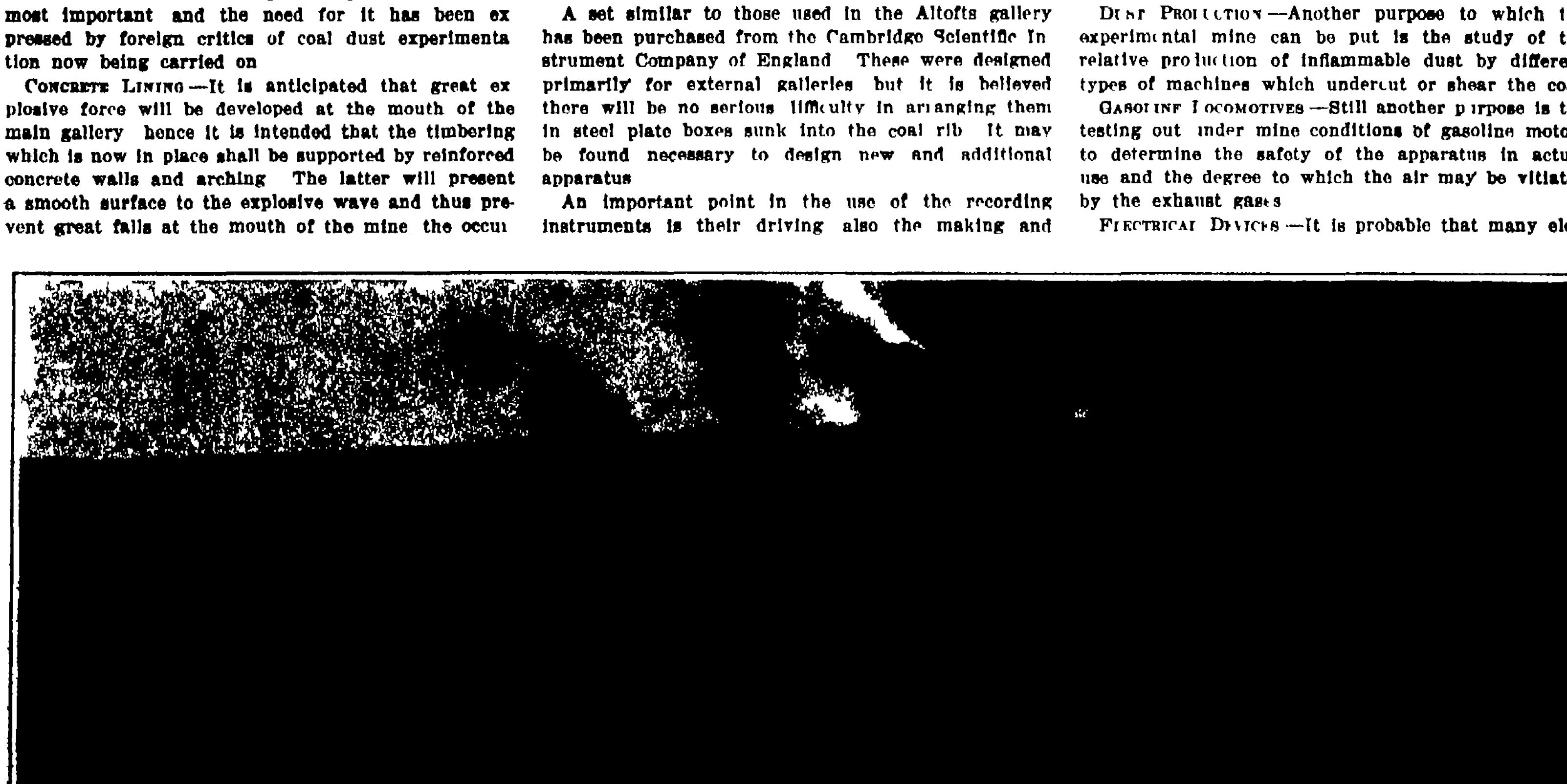
Dust Production —Another purpose to which the experimental mine can be put is the study of the relative production of inflammable dust by different types of machines which undercut or shear the coal

Gasoline Locomotives —Still another purpose is the testing out under mine conditions of gasoline motors to determine the safety of the apparatus in actual use and the degree to which the air may be vitiated by the exhaust gases

Electrical Devices —It is probable that many electrical mining devices can be tried out under actual service together with tests of insulation of wiring

Concrete Also Steel Timbers and Props —The growing scarcity of mine timbers, as well as the danger of fire from their use suggests the importance of testing reinforced concrete timbers and ties also steel props and ties in the experimental mine

The relative advantages of brick arching and reinforced concrete for lining the main entries can also be studied, and under severe conditions



EXPLOSION CHAMBER AT MOMENT OF DISCHARGE

The Production of Light by Living Organisms*

The Chemistry of Biophotogenesis

By F. Alex McDermont,

Division of Chemistry, Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, D. C.

The term "Biophotogenesis," in its complete sense of the production of light by living organisms, covers a group of phenomena accompanying the vital processes in a wide range of animal and vegetable forms. The fireflies (*Lampyridæ*) are to us the commonest and most brilliant of these biophotogenic forms.

During the summer of 1909 the writer was associated with Professor Joseph H. Kastle of the University of Virginia (then Chief of the Division of Chemistry of the Hygienic Laboratory) in a study of the effect of various chemical reagents on the luminous tissue of the firefly common in this locality (*Photinus pyralis* Linn.), and the results of our work are contained in a paper entitled "Some Observations on the Production of Light by the Firefly," in the *American Journal of Physiology*, Vol. 27, pp. 122-151. At the time this work was started Professor Kastle was engaged in the preparation of his monograph on "The Oxidases and Other Oxygen Catalysts Concerned in Biological Oxidations" (Bulletin No. 59, Hygienic Laboratory), and a latent interest in this subject was awakened by the recurrence of references to the claim of Dubois that the photogenic process in organisms involves the action of an oxidizing ferment or oxidase to which this investigator had given the name "Luciferase." Professor Kastle's prior observations on this point had led him to believe that no oxidase was present, but that peroxidase and catalase were present; he found that aqueous extracts of the luminous tissue of the common firefly failed to turn tincture of guaiacum blue, except in the presence of hydrogen peroxide, and the bluing in the presence of the latter was accompanied by the rapid disengagement of oxygen.

This insect, *Photinus pyralis* Linnaeus, is the one which is so very common in our parks and lawns during the summer. It is a species of the family *Lampyridæ* (fireflies, lightning bugs) of the genus *Coleoptera* (beetles). The luminous apparatus of the male insect—the more commonly seen of the sexes—occupies the entire ventral surfaces of the two abdominal segments next to the last and a portion of the preceding segment. That of the female is a small rectangular area on the third abdominal segment from the last; both sexes have also two very small points of luminous tissue on the last abdominal segment.

The color of the light of this insect is generally stated to be yellow or yellowish green; some of the other local species exhibit a light of a slightly different tone. The light of the *pyralis* has recently been made the subject of a very interesting spectrophotographic study by Drs. Ives and Coblentz at the Bureau of Standards (*Bulletin of the Bureau of Standards*, Vol. 6, pp. 321-316). These observers found the light of this insect to resemble very closely the light of the Cuban cucuyo (*Pyrophorus noctilucus* Linn.), as studied and described by the late Professor S. P. Langley and Professor F. W. Very nearly twenty years ago ("The Cheapest Form of Light," Miscellaneous Collections, Smithsonian Institution, 1901 reprint). Briefly the spectrum of the light of *Photinus pyralis* consists of a structureless unsymmetrical band in the red, yellow, and lower blue portions of the visible spectrum, with a maximum at that portion having the greatest illuminating effect, with the minimum of actinic and thermal effects; it gives no hint of continuation in the infra-red or ultra-violet portions of spectrum. It seems probable that the light of most luminous insects is essentially similar to that of the *pyralis*; two other species of Lampyridæ that I have examined have lights showing spectra of even more limited range than that of the *pyralis*, and in both of these species the color of the light to the eye is more greenish than that of the commoner insect. However, Mr. H. S. Barber of the U. S. National Museum (Proceedings of the Washington Entomological Society, Vol. 9, pp. 41-43) and other observers have reported that various species of tropical *Phengodini* (a group of beetles probably closely allied to the Lampyridæ) give a red light from a photogenic organ in the head; no spectroscopic studies of this light have been made. Max Trautz ("Studien über Chemilumineszenz," *Zeitschrift für physikalische Chemie*, Vol. 53, pp. 1-111) states that the spectrum of the light produced by the oxidation of pyrogallol by means of thirty per cent hydrogen peroxide in the presence of formaldehyde extends from the red to the lower blue, and therefore covers very nearly the same spectral area as that of the light of the firefly. The spectrum of the light of glowing phosphorous also appears to give a spectrum lying within this same area, though of less extent than that of the firefly. Although a little ahead of the subject, I will state here that the light produced by moistening with 3 per cent hydrogen peroxide solution the luminous tissue of the firefly which has been desiccated over sulphuric acid in an atmosphere of hydrogen gives a spectrum of very limited range, extending from the orange to the yellow-green. The spectrum of the light produced by the photogenic bacteria is also of less range than that of the *Lampyridæ*.

It need scarcely be said that the light of the firefly affects the photographic plate, obviously spectrophotographic studies could not otherwise have been made upon it. Dubois has taken photographs by means of the light of the photogenic bacteria and of the cucuyo. In 1896 Muraoka (*Annalen der Chemie und Physik*, Vol. 295, pp. 773-781) announced that he had proved the penetration of metal films by means of the light of the firefly in a manner similar to that of the X-rays. This was very puzzling to physicists in view of the known limited range of the light and the fact that it gave no other evidence of containing ultra-violet or penetrating rays. I have experimented with the local insect (*Photinus pyralis*) and have failed to find the least evidence of penetration of thin sheet copper, aluminium foil or the ordinary black paper with which X-ray plates are wrapped. Some explanation of Muraoka's rather extraordinary results has been offered, based upon some more or less vague bacterial or vapor influence, but when we consider that his results were published only a little while after the discovery of the X-ray it seems possible that Muraoka was just a little over enthusiastic.

Professor Kastle and the writer tried the effect of a large number of chemical substances upon the live insect, the freshly detached luminous organ, and the luminous tissue which had been dried in hydrogen, and for these in detail the reader is referred to the paper in the *American Journal of Physiology*, ante. A great deal of work had already been done along similar lines, some of it dating back to the times of Reaumur and Spallanzani; Ehrenberg, Milne-Edwards and Pflüger have in turn reviewed this literature quite thoroughly.

Some of our results, however, seem worthy of special attention. Taking first the live insect: Injections of solutions of the metallic nitrates, of strychnin and of adrenalin caused the emission of light. Immersion of the insect in methyl and ethyl alcohols, in ether and in chloroform resulted in the production of light. Immersion in pure oxygen appeared to stimulate the photogenic function somewhat, but not as much as might have been expected. Immersion in nitrous oxide caused a considerable increase in the intensity of the light. In the cases of injection and immersion in liquids the reagents kill the insect, but not until they have caused light-emission. Nitrous oxide narcotizes the insect, but in the air it recovers again. Hydrocyanic acid and cyanogen kill the insect, of course, but not until they have caused the emission of light. The luminous organ of one of the local species of *Lampyridæ* has been observed to glow in the mixture of air and prussic acid in the cyanide killing-bottle for over an hour long after the actual death of the insect. Ammonia water causes the evolution of light, either by injection or immersion. Watasé is authority for the statement that if a tissue suspected of being luminous refuses to give light with any other stimulus it will, if a true photogenic tissue, glow on moistening with dilute ammonia water. The injection of 3 per cent hydrogen peroxide solution also caused the evolution of light.

With the freshly detached luminous segments the most notable results were obtained with the vapors of methyl and ethyl alcohols, carbon tetrachloride and bisulphide and mononitrobenzene acting in the presence of air. All of these reagents caused light emission, and the light given out was not the continuous faint glow frequently the result of weak chemical stimuli, but was accompanied by a series of distinct flashes or pulsations of light similar to the normal flashes of the insect. With the detached organ the effect of powerful poisons was in almost every instance to produce the evolution of light, sometimes faint and of short duration, but definite. As examples of poisons acting thus may be cited hydrofluoric acid, iodin cyanide and bromine.

The interesting fact that the photogenic tissue of luminous life-forms preserves after desiccation the power to evolve light on the application of water in the presence of air or oxygen has long been known, and it at once suggests other known instances of the preservation of biologic activity by drying, as exemplified by the yeasts and ferments. By drying the photogenic tissue of *Photinus pyralis* over sulphuric acid in hydrogen or a hydrogen vacuum, we have prepared dry material which has retained its photogenic activity apparently without loss, when kept in sealed tubes for over thirteen months; indeed there seems to be no good reason why, under these circumstances, it should deteriorate. In its conduct toward various chemical substances, the dried tissue after moistening does not differ essentially from the live insect or the freshly detached luminous organ. It glows on moistening in the air, somewhat brighter on moistening in oxygen, and but dimly or not at all when moistened in nitrogen, hydrogen and carbon dioxide. Moistened with 3 per cent hydrogen peroxide instead of water the dried tissue produces a much brighter light than with water alone, accompanied by the decomposition of the peroxide. The spectrum of the light thus produced has already been referred to.

Thus far one substance alone has conducted itself as a positive inhibitor of the photogenic function. This is sulphur dioxide. Carradori observed this fact with the *Luciola italica* over one hundred years ago; Dubois has made a similar observation with regard to the cucuyo. The live insect, the freshly detached luminous organ and the dried tissue placed in this gas all fail to glow, or glow but weakly and momentarily, and are dead to all other stimuli when removed from it. As a rule even those substances which tend to poison the luminous tissue caused the evolution of a dim light at first, but not so with sulphur dioxide in the majority of cases in which we used it.

Mechanical stimuli, such as friction and percussion, and physical stimuli, such as electricity, heat and light, also cause the production of light by the luminous organs of the firefly, whether attached to the living insect or detached. The effects of various temperatures and of electric discharges of various strengths have been extensively studied by other observers. Transferring the detached luminous organs from one gas to another, even though one or both be chemically neutral, may cause light production, apparently due to some osmotic effect. Currents of air and other gases exert an effect on these detached organs which Professor Kastle has compared to the effect of air currents on the strychninized frog. It is obvious from these facts that the luminous tissue is one of great irritability.

Our knowledge of the chemical processes involved in biophotogenesis is very meager. The luminous organ of *Photinus pyralis*, in common with those of the other *Lampyridæ* which have been studied, consists of two layers of cells under the outer transparent chitin. These layers of cells are penetrated by numberless tracheæ, the ends of which appear to be connected by a network of very fine tracheoles, the whole system resembling the finer veining of a leaf. On the inner surface of the organ these tracheæ unite to form larger passages. It is practically certain that during the life of the insect these tracheæ are filled with air. Of the two cell layers, the outer consists of a mass of some special type of nucleated cell of unknown nature penetrated by the aerophore cylinders, while the inner layer is composed of guanine and sodium or ammonium urate, and probably serves as a reflector. These guanine reflecting layers have also been found in the luminous organs of various fish and cephalopods, whose names I will not attempt to inflict on the readers of this paper. The luminous apparatus of these fish and other of the higher sea-forms is quite highly developed, there frequently being a definite lens with a light-producing body back of it, and behind this a guanin reflector, sometimes with a roughly parabolic section.

It is pretty well established that all photogenic organisms require at least two constant chemical factors in order to exhibit their luminous property, viz., the presence of oxygen and of moisture. Bischoff has claimed that the photogenic process in the luminous rhizomorphs (mycelia) is accompanied by the absorption of oxygen and the evolution of carbon dioxide, and other observers have made similar

* From a paper read before the Chemical Society of Washington, October 13th, 1910.

claims for other cases of biophotogenesis, my own observations tend to support these claims, but as yet the evidence is somewhat too meager at least so far as the evolution of carbon dioxide is concerned Dubois's theory assumes the oxidation of a substance of unknown composition to which he has given the name "Luciferine, through the agency of the oxidase Luciferase.' Until more definite data are at hand, it would seem that this theory requires some caution in acceptance The facts so far as known certainly present some analogy to other known biologic processes and it is not at all impossible that his explanation may be correct Watasé expresses the view that in *Noctiluca miliaris* and other simple luminous forms the 'phosphorescence is associated with the contractility of protoplasm as a potential property of all protoplasm whether exhibited or not, and he rather leaves the reader with the impression that he believes that the particles of food materials are actually burned in the living tissues with the production of an incandescent temperature (*Protoplasmic Contractility and Phosphorescence* Biologic Lectures Woods Hole Mass 1898) Jousset de Bellesme in 1880 (*Comptes Rendus de la Academie des Sciences* Paris) stated that he believed the light to be due to the spontaneous combustion of phosphine liberated by the decomposition of protoplasm and Sir Humphry Davy noted that Lavoisier held a similar view The nature of the substance consumed in this biologic oxidation—the *Noctilucin* of Phipson the *Luciferine* of Dubois and the *Photogene* of Molisch—has been variously regarded by different authors Many seem to have regarded it as a fat or a fat-like substance Phipson, who apparently isolated and analysed a culture of photogenic bacteria concluded that it contained nitrogen, Kölliker and Macaire believed it to be an albuminous body Embryologically it appears to be an extension of the fat layer Various observers have found the urates and phosphates of ammonium sodium, potassium and calcium in the luminous tissue and its ash Dubois at one time seems to have rejected the oxidation theory and to have believed that the light was due to the spontaneous crystallization of ammonium urate All attempts to definitely extract and analyze the active substance have failed When the luminous organs are treated with alcohol or ether in an atmosphere of hydrogen the liquid acquires a yellow color but no light-emission occurs when it is exposed to the air or treated with hydrogen peroxide Lecithin does seem to exist in the insect in small amount

An interesting circumstance in this connection is the existence in certain luminous organisms of a substance whose solutions exhibit a brilliant blue fluorescence Dubois found this substance in the cucuyo and Dr Coblentz has found it in *Photinus pyralis Photinus corrucus* and *Photuris pennsylvanica* I have found it in *Photinus scintillans* also Dubois regarded the substance he extracted from the cucuyo as analogous to esculin (a glucoside which is present in the bark of the horse chestnut and whose solutions possess a blue fluorescence) and he regarded it as essential to the photogenic process attributing to the actinic properties of the blue rays in its fluorescent light the actinic power of the emitted light of the insect. Personally I am inclined to regard the fluorescence simply as an incidental property dependent on the structure of some compound frequently met with in insects of this nature much as Jordan regards the fluorescent pigment of *Bacillus fluorescens liquefaciens* Fluorescent extracts of the *pyralis* are produced by extraction with alcohol ether and water but not by chloroform benzene or carbon tetrachloride The fluorescent material is not precipitated by lead acetate mercuric chloride ammonium sulphate nor chlorplatinic acid It appears to be a solid at ordinary temperatures though as emitted by the insect it is contained in a sticky exudation which soon hardens in the air

We cannot say now what possibilities lie before us in the discovery of the secret of the firefly particularly as to the kind of oil he uses in his little lamp Perhaps it will be discovered and turned to practical account The emitted light of the firefly is far from being a good light for general illumination in spite of its luminous efficiency of 96 5 per cent on account of the very limited range of color effects possible under it A single firefly has been variously estimated to give from 1 840 to 1 1600 of a candle power so we would need quite a high firefly power to light our homes and streets by biophotogenic light There are still many gaps in our knowledge of this interesting subject in spite of the large amount of work that has already been done but one by one we hope to close these up and discover the secret of The Cheapest Form of Light

The Camphor Industry*

Japanese and Formosa Methods

Camphor produced from the camphor tree (*Cinnamonum camphora*) has a large use not only as a drug but more especially in the celluloid industry where it is used in the transformation of cellulose nitrate to celluloid It is used extensively in the manufacture of smokeless powder in the making of substitute leathers and generally in the plastic pyroxylin industry

Imports of crude camphor into the United States for the fiscal year ending June 30th 1910 were 3 026 648 pounds valued at $921 926 refined and synthetic camphors added to this 477,269 pounds valued at $179 965

The sources of camphor are practically all foreign Experimental plantations in the United States will not be ready for production within three or four years and while the indications are all toward the success of this venture the commercial production of camphor on a large scale in this country is not to be expected in the immediate future

At present barring the production of synthetic camphor our sources of supply are the East Indian Islands Borneo Sumatra and particularly Japan and Formosa In Japan and Formosa the camphor trade is a government monopoly All camphor and camphor oil produced must be sold to the monopoly bureau The amount of camphor to be placed on the market the price to the producer and to the vendee are fixed by the government

The privilege of engaging in the industry is granted by the government to individuals and companies on application The applicant is required to furnish some evidence of his financial standing A certain territory is allotted to each operator and he must confine his operations to that tract.

The trees are found only in mountainous districts In Formosa they are in the interior, where the collection of camphor is rendered hazardous by the presence of the head hunting tribes which infest the region Conditions have improved in this respect since the Japanese occupation of the island owing largely to the conciliatory policy adopted by the Japanese officials yet in 1909 there were 96 workmen killed by the savages Owing to the danger of attacks by the tribes wages are high being 90 cents gold for a native and $2 for a Japanese

The condition and extent of the forests have been variously estimated It is sometimes stated that the camphor forests are inexhaustible Again it is estimated that the Formosan forests will be exhausted in twenty years. As a matter of fact the truth is between these limits, perhaps forty five years of production at the present rate will use up all the trees now workable.

However, the government and private individuals have been planting young trees. About 15 000 000 trees have been set out since 1901 and with a continuance of the policy of yearly planting it is probable that there will always be a sufficient supply of producing trees.

All camphor trees do not produce camphor. In Borneo for instance it is said that only one tree out of 100 bears camphor crystals The lumber from the trees is valuable however and is much used for building as it is less subject to the ravages of the white ant than most woods If the camphor odor is quite strong the boards may be used for insect proof boxes

In selecting the trees which are to be treated to extract the camphor there is nothing in the outside appearance to guide the searcher Chips are taken from the trees and if the camphor odor is absent the tree is not cut The trees sometimes are 3 or 4 feet in diameter and 180 feet tall If the odor from the chips is sufficiently strong a search is made over the tree for a flaw in which the camphor gum may have collected The tree is cut off below the flaw and the wood split away in order to find the deposit. The flaw may be from 4 to 6 feet long and may contain up to 14 pounds though 7 pounds would be above the average

In Japan and Formosa the body of the tree which contains camphor is cut into chips by the workers who use for this purpose a chisel like knife The finer the chips the more suitable they are for distillation They may be taken from trunk limbs roots or twigs The chips are now distilled in an apparatus of native manufacture which is crude but better than mechanical devices which have been imported from Europe

Over a fireplace is a pan filled with water Above the pan is a very tight circular wooden retort about 3 feet in diameter at the bottom and 1 foot at the top and 5 feet high.

This retort is filled through an opening in the top with the camphor wood chips The opening is then closed by a double lid and earth banked around the lower section of the retort prevents the escape of the camphor fumes. Just above the water pan are thin slats of perforated bamboo through the apertures of which steam passes into the chips above extracting the camphor Near the top of the retort are two bamboo pipes through which the vapors are conducted to a cooling box about 10 feet distant This cooling box is divided into two compartments the lower is filled with cool water and the upper contains a wooden screen upon which the camphor crystallizes Connected with the cooling box is another of exactly similar description called the crystallization box Both are immersed in water which hastens the process of crystallization Distillation requires about 24 hours The chips are then removed through an opening in the lower section of the retort

The two products of the distillation are crude camphor and camphor oil The camphor is crystallised on the screens of the boxes The oil is caught in leads and also skimmed from the water in the cooling boxes.

The camphor and camphor oil thus obtained are shipped to Kobe Japan where the camphor oil is further treated It is heated in small cast iron stills and the fraction having a specific gravity 0 825 to 0.980, which contains 45 to 55 per cent of camphor, is cooled to allow the camphor to crystallize out. When ready the crude camphor is drained out of the oil by filtering through cloth bags

After draining for a few days this product is packed in tubs and after some months gives by rearrangement crystals quite as large and firm as those of the crude camphor produced from the wood

These two grades produced from the wood and from camphor oil when mixed at the monopoly plants constitute what is known as grade B or commercial crude camphor This is used by the American trade

In the government refineries the B grade is somewhat purified and yields the BB grade which is exported along with the B grade to European markets This is also the grade supplied to the seven companies licensed by the government for refining They sublime the camphor producing a clear block of pure camphor

There are two kinds of camphor on the market—the Japanese $C_{10}H_{16}O$ or ordinary camphor and Borneo camphor obtained from *Dryobalanops camphora* $C_{10}H_{17}OH$ The latter is more expensive owing to the demands of the Chinese trade and is seldom in American or European markets It can however be produced by reduction of ordinary camphor The odor of Borneo camphor or borneol is much like that of ordinary camphor but it has in addition a somewhat peppery smell

The tremendous increase in the use of camphor caused an increase in exports from Japan and Formosa from 620 000 pounds in 1868 to 8 427 000 in 1907 and at the same time a rise in price of from $16 42 to $168 50 per 220 pounds Owing to the extraordinary prices industrial chemists were led to investigate the question of producing synthetic camphor with such success that in 1905 and following they were able to compete with the natural product In 1908 the effect upon the market of synthetic camphor was such as to reduce imports of natural camphor nearly one half as compared with 1907

Immediately following however Japan and Formosa were able to quote prices so low that practically all of the firms manufacturing synthetic camphor have been forced to discontinue operations and natural camphor not only has regained its old market but is striving with success to find new ones mainly in the extreme East It is true however that the rapidly increasing price of turpentine may have had something to do with this condition of affairs and also that in a few cases notably that of the Chemische Fabrik a A vorm A. Schering of Berlin it seems possible to make the artificial product and keep its market under present conditions

Many patents have been taken out covering processes for the formation of synthetic camphor but all are attempted improvements on the one original discovery—i e that pinene a hydrocarbon in turpentine could be converted

The methods for effecting the transformation are various but all follow practically the same line Pinene $C_{10}H_{16}$ is treated with HCl or oxalic acid In the first case the pinene hydrochloride is heated under pressure with acetate of lead in acetic acid, causing

* From U. S. Consular Report.

the formation of camphene which has the same empirical formula as pinene $C_{10}H_{16}$ but is of a different structure and is therefore easily oxidized to camphor potassium permanganate being used to produce the change.

In the second case where oxalic acid is used instead of pinene hydrochloride we have a mixture of camphor pinyl formate and pinyl oxalate. This is washed with water and the oxalate and formate are saponified whereby camphor and borneol are formed. The mixture is distilled and the borneol is oxidized by means of chromic acid to camphor. Other modifications are very numerous over 200 patents having been taken out but these two examples are sufficient to show the general lines on which the synthesis is carried out.

The firm of A. Schering of Berlin which has been able to continue the manufacture does not disclose its special methods and laboratory equipment. It is generally understood that it has followed along the lines of original German patents the second case previously mentioned. How much further it can follow a downward move in prices is not known, but competent persons feel that the limit will soon be reached.

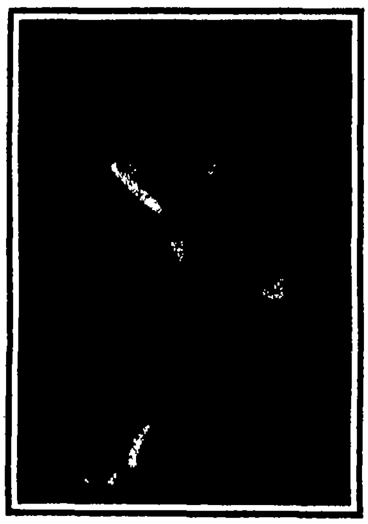
The establishment of the industry in the United States might not be so difficult. The obtaining of turpentine is an easy matter and while not considered so good as the French turpentine the American ranks next in favor with manufacturers.

Another fact in favor of American manufacturers would be the import duty of 6 cents per pound which is levied on both refined and synthetic camphor.

A Quarter Century of Experimental Embryology

Wilhelm Roux and His Work

Twenty-five years have passed since Wilhelm Roux published his first contribution to the mechanics of development, in which he indicated an effective method of analyzing the complex process by which an individual organism is developed and described a series of preliminary experiments. He had previously published observations and a theory of the functional adaptation produced in organs by exercise in performing special functions.

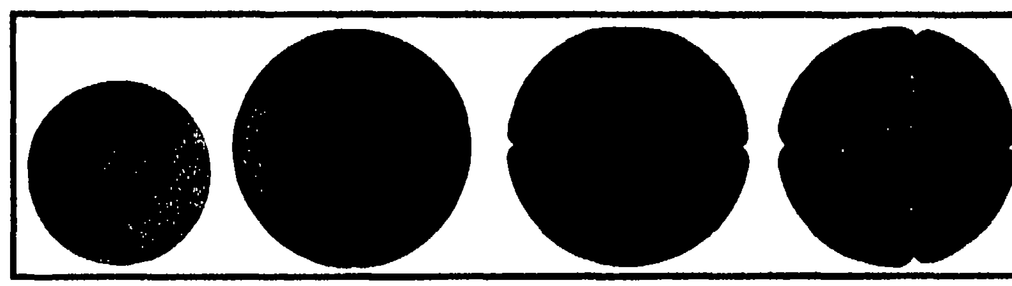


PROF. WILHELM ROUX

Wilhelm Roux who is now professor of anatomy at Halle received on his sixtieth birthday June 9th 1910 an honorary address signed by more than eighty men of science.

The following sketch of the new branch of science by Prof. Albert Halle in the *Illustrirte Zeitung* is based chiefly on its founder's own work.

Experimental embryology or the mechanics of evolution deals with the development of the complex living organism from the apparently simple egg. The only effective method of studying the causal factors of this development is found in selective experiment guided by a mental analysis of the complex phenomena. Roux began by determining the epoch of the first conspicuous change in the egg the establishment of the principal axes of the embryo and subsequently succeeded in discovering the factors which normally produce this change. Some of the initial stages in the development of a frog embryo are shown in Figs. 1 to 5. Roux first proved by experiment that in normal development the deep furrow which appears soon after fertilization and divides the egg into two equal segments (Fig. 3) subsequently becomes the plane of symmetry between the right and left halves of the embryo (Fig. 5). The next question was whether or not the future position of the plane of symmetry is indicated in the egg before fertilization.



1. Side view 2. Top view of egg soon after fertilization 3. First furrow 4. Second furrow

Figs. 1 to 4.—Initial Stages of Development of a Frog's Egg.

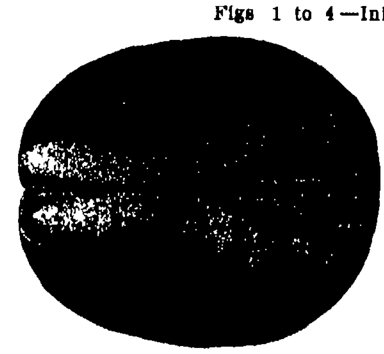
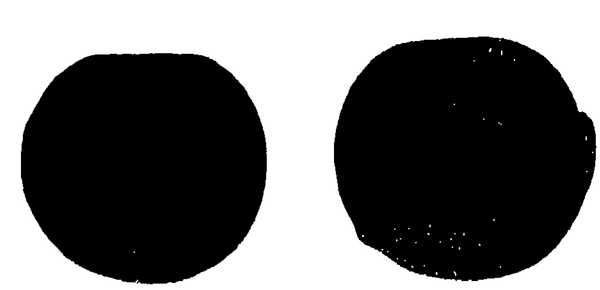
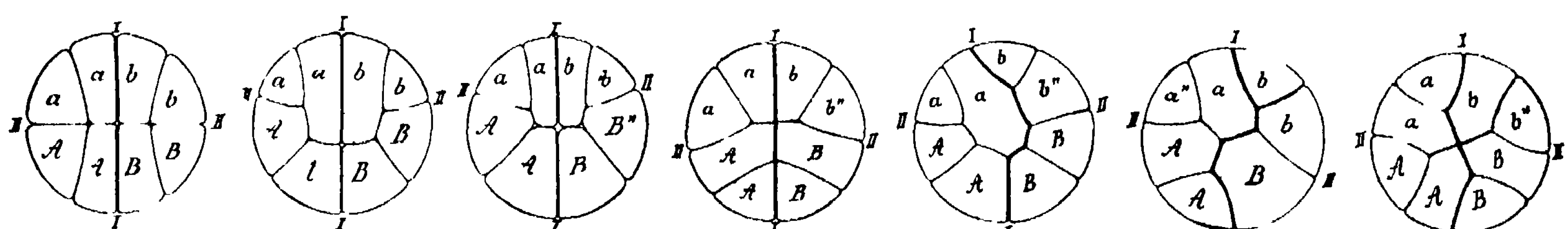


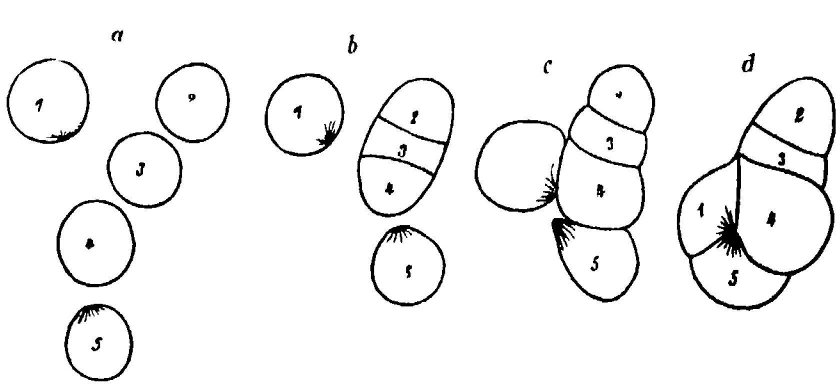
Fig. 5.—Very Young Frog Embryo.



Figs. 6 and 7.—Development of Brain and Spinal Cord.



Figs. 8 to 14.—Artificial Segmentation of Floating Oil Drops.



Figs. 15 to 18.—Cytotropism.

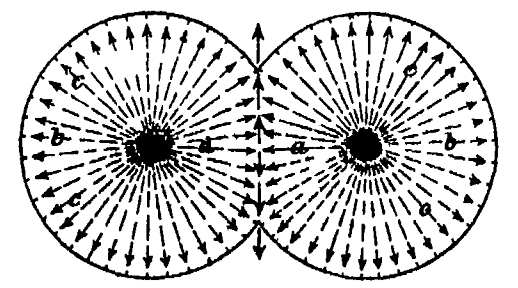
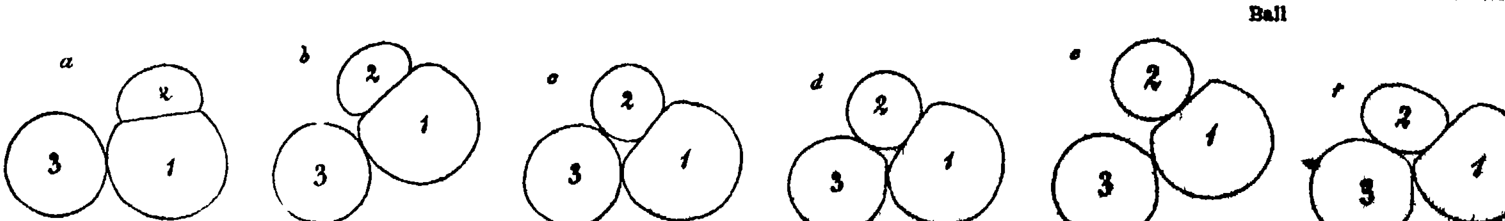


Fig. 25.—Apparent Attraction of Drops of Chloroform.

Fig. 26.—Cell-destroying Needle With Heated Brass Ball.



Figs. 19 to 24.—Another Example of Cytotropism, or Elective Affinity of Cells.

The egg of the frog (Figs 1 and 2) is composed of a dark and a light hemisphere The material of the dark hemisphere is employed chiefly in forming the embryo while the light hemisphere consists principally of food for the growing embryo These food stuffs are heavier than the contents of the dark hemisphere. Shortly after fertilization when the egg has become free to rotate in the rim by which it is attached to its environment (Fig 2) it turns so as to bring the dark hemisphere above the rim and the light hemisphere below In the egg of the green water frog this adjustment is not made accurately but the division between the light and dark hemispheres is considerably inclined as is shown by the side view (Fig 1) and the view from above (Fig 2)

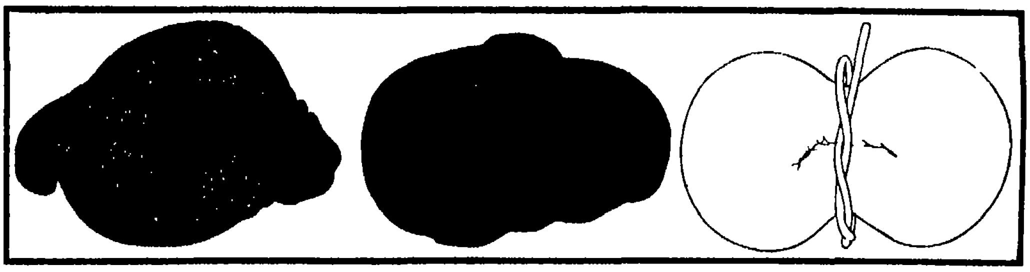


Fig 27—Embryo Developed From Left Half of Frogs Egg

Fig 28—Embryo Developed From Front Half of Frogs Egg

Fig 29—Salamander Egg Constricted to Form a Double Monster

It was found that the first segmentation furrow (Fig 3) divides each hemisphere symmetrically and that the head of the embryo is always formed at that end of the egg (the right end in the illustrations) where the light-colored hemisphere is partly visible from above the opposite end corresponding to the tail of the embryo Unfertilized frogs eggs floating motionless on a solution of albumen also assumed an oblique position Hence the direction of the axis of the embryo and the position of the plane of symmetry appeared to be indicated before fertilization but it was proved by very ingenious experiments that the oblique position first assumed is changed after fertilization so that fertilization is required to determine the exact position of the axis. Then Roux succeeded in fertilizing the egg along an arbitrarily selected meridian by making an incision and thus enabling some spermatozoa to gain a headway of several minutes over the rest This meridian always assumed a vertical position coincident with the first furrow and the plane of symmetry Other experiments showed that this result was due to a re-arrangement of the yolk caused by the spermatozoa and that still greater changes could be produced by holding the egg in arbitrary inclined positions

The dark upper hemisphere had been assumed to correspond to the back of the frog but Pflueger and Roux have proved that the brain and spinal cord are developed from two ridges which originate near the right and left sides of the horizontal equator and descend until they come together at the middle of the light-colored lower hemisphere (Fig 7)

Fig 32—Double Head of Embryo Shown in Fig 31

For the purpose of determining the factors that initiate the process of cell division in the egg Roux divided by means of a glass rod a circular film of oil floating on a mixture of alcohol and water (Figs 8 to 14) He found that nearly all arrangements of cells or segmentation patterns, which occur in the eggs of animals can be imitated in this way and that these patterns differ only in the relative sizes of their segments and the order of arrangement of large and small segments.

"Artificial diminution of some of the segments was found to produce the same result in oil drops and in living eggs, if effected soon after segmentation

Roux also discovered phenomena of attraction which he called cytotropism, between detached cells of the egg When a frog's egg which had developed numerous cells was shredded, immersed in a suitable liquid and examined with a microscope, detached cells were seen to approach each other with an intermittent motion When several cells have come close together the phenomena become more complex Two cells may come together unite closely and then separate and form other associations In Figs 15 to 18 the cell 1 attaches itself to 3 then separates and forms a closer union with 5 In Figs 19 to 24 the approach of cell 3 causes 2 to leave 1 and attach itself to the newcomer

As the nuclei of the spermatozoon and the ovum approach each other in a straight line from a relatively great distance inside the egg Roux endeavored to bring about a similar result with lifeless matter He found that drops of chloroform floating on a saturated solution of carbolic acid approach each other from great distances but that this apparent attraction is caused by repulsion between the drops and the solution and by the one sided protection against this repulsion which each drop affords the other (Fig 25)

More than twenty years ago Roux discovered that when one half of a frogs egg in the first stage of segmentation (Fig 3) was destroyed with a specially constructed heated needle (Fig 26) the remaining segment could develop into a perfect right or left half or even a front half of an embryo The ceiling of Roux s private laboratory is decorated with copies of these monstrosities (Figs 27 and 28) Before this discovery it was assumed that the whole egg was required for the normal development of each part of the embryo

Equally surprising was the discovery that one of these half embryos can supply the missing half and develop into a complete embryo by a process which Roux has named postgeneration Several experimenters then succeeded in producing two complete embryos by separating the two first segments of one egg by various methods and evenly constricting with a thread an egg in an advanced stage of development (Fig. 29) Fig. 31 shows a double salamander with Spemann produced by this latter method Fig 32 the structure of the double head and Fig 30 the normal single form

Conversely it has been found possible to combine two eggs to form a single embryo and to graft two embryos together to form a double monster The parts of these monsters developed independently until they died of inanition (Figs 33 to 38) The operation succeeded even with tadpoles of two different species (Figs 37 and 38)

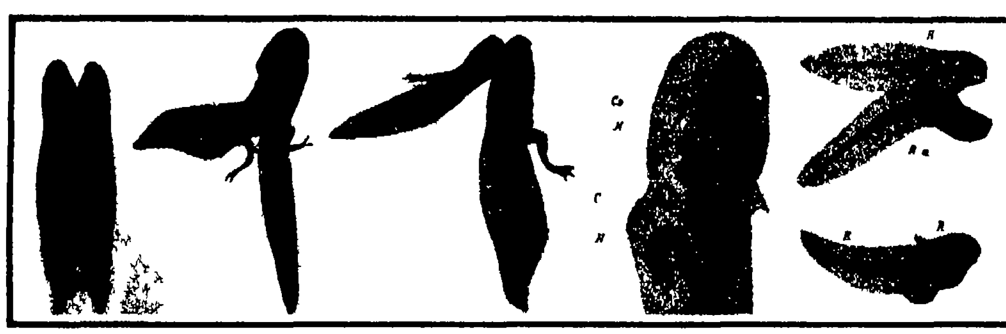
Examples of independent development of parts of

Fig 30—The Embryo of a Normal Salamander

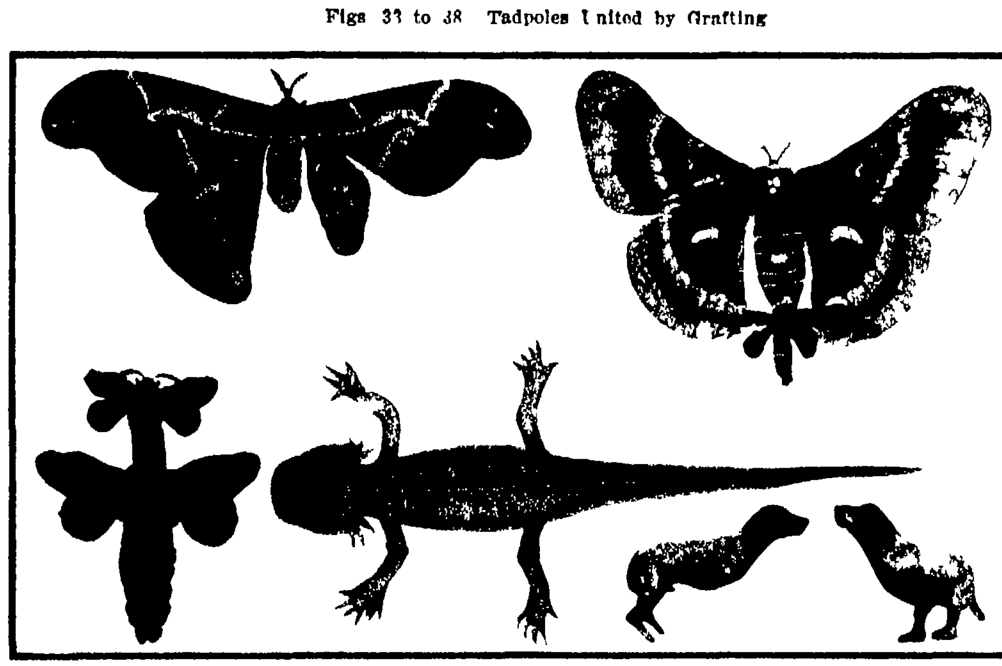
Fig 31 Double Embry Produced by Constricting Salamander Egg

the embryo have been observed also in insects The American biologist Crampton has produced monstrous butterflies of astonishing forms by combining parts of pupæ belonging to different species (Figs 39 to 41)

Barfurth and Tornier have produced amphibia with supernumerary toes by amputating limbs slitting the stumps and keeping the wounds open (Fig 42) Double tails were produced by a similar process The fact that an artificial division produces additional toes or tails and not merely a cleft foot or tail is very important in connection with the causal factors of development



Figs 33 to 38 Tadpoles United by Grafting



Figs 39 to 41—Grafted Butterflies

Fig 42 Axolotl with Supernumerary Toes

Figs 43 and 44—Kangaroo x Dogs

Some of these amazing results plainly indicate that the individual is not developed according to the same fixed plan in all circumstances but that the embryo is able to adapt its development to various conditions For this and other reasons Roux thirty

years ago recognized automatic regulation of function as an essential and characteristic property of living organisms. *In post-embryonal life this regulation is manifested chiefly in recovery from disease and in the functional adaptation to which allusion has already been made.*

A very interesting example of this functional adaptation was observed by Fuld, a pupil of Roux, in the case of dogs born without fore-legs, which stood and hopped in the manner of kangaroos (Figs. 43 and 44). When these dogs had attained their full growth Fuld found that their thigh bones, originally shorter than the lower leg bones, had become longer than the latter, as is the case in kangaroos. These interesting creatures have been jocularly named kanga-Roux dogs. Another pupil of Roux found a similar excessive development of the thigh bone in four members of a Polynesian tribe of crouching habit.

In conclusion I will mention an experiment which may indirectly affect surgical practice. Prof. Kaneko of Japan, working in Roux's institute, inserted silk fibers round the bones of narcotized dogs through and beneath the muscular attachments. The silk became covered by a sheath of cartilage, such as is normally formed over a nerve or a blood vessel which occupies a similar position relatively to a bone in the embryo. Furthermore, Levy has shown that tension can cause the formation of connective tissue along the line of stress.

The important and surprising results obtained by Jacques Loeb, Edmond Wilson and many other workers in this new field cannot be here described. Enough has been said to show the great theoretical importance of this line of research. The art of medicine, especially *in its surgical and orthopedic departments*, will also gain thereby. A beginning has already been made in the "analytical orthopedy" which was theoretically formulated by Roux twenty years ago. In this method the orthopedic capacity of every tissue involved in a malformation is deduced from experiments on animals or from the results of surgical operations, and the knowledge thus obtained is utilized in devising treatments adapted to each tissue. Furthermore, many bold and successful new surgical operations, such as the transplantation of the kidney, are based on the principles laid down in the essay on "The Conflict of Parts in the Organism," which Roux wrote many years ago.

Road Making in the United States

The Present Status of the Use of Bituminous Materials

The development of the use of bituminous materials in the construction and maintenance of roads in the United States since 1908 is worthy of careful *consideration and critical analysis.*

The bituminous materials which have been used in the United States during the past three years may be classified as follows: Fluxed native asphalts, oil asphalts, residual asphaltic and semi-asphaltic oils, light oils, coke-oven tars, coal-gas tars, water-gas tars, and combinations of coal-gas and water-gas tars, combinations of asphaltic materials and tars.

The nomenclature used to designate the various kinds of tars is self-explanatory. In order to avoid misunderstanding, the terms used in connection with asphaltic materials will be defined, the definitions given being abstracts of those proposed by Prevost Hubbard, chemist, United States Office of Public Roads.

Fluxed native asphalts are native asphalts fluxed with a heavy petroleum residuum. Native asphalts are solid or semi-solid native bitumens consisting of a mixture of hydrocarbons of complex structure, *free from any appreciable amount of solid paraffins,* melting upon the application of heat, and evidently produced by nature from petroleums containing little or no solid paraffins. Unrefined native asphalts with few exceptions contain water, vegetable matter, clay, sand, etc.

Oil asphalts are solid or semi-solid products produced by the distillation of semi-asphaltic and asphaltic petroleums.

Residual asphaltic and semi-asphaltic oils are heavy viscous residues produced by the evaporation or distillation of crude asphaltic and semi-asphaltic petroleums until at least all of the burning oils have been removed, and often some of the heavier distillates as well.

The term light oils includes crude and partially refined paraffin petroleums, semi-asphaltic petroleums and asphaltic petroleums.

Paraffin petroleum is an oil the base of which is composed *principally of the paraffin hydrocarbons.*

Semi-asphaltic petroleums are oils containing a semi-asphaltic base, i. e., oils whose residues produced by evaporation or distillation, while composed mainly of asphaltic hydrocarbons, contain also a certain percentage of paraffin wax.

Asphaltic petroleums are oils containing an asphaltic base, i. e., they are capable of producing residues very similar to native asphalts if evaporated or distilled down to the consistency of such asphalts. They contain little or no solid paraffins. Native asphalts are probably produced from such oils by natural processes.

As typical of the practice in the United States will be cited the work of seven State highway departments which have used bituminous materials extensively. The writer wishes at this time publicly to thank the highway departments of the States mentioned below for their co-operation in collating the following information. *The figures given refer to the* total amount of work of the various types indicated which has been accomplished in 1908, 1909 and 1910 by the State highway departments of the States of Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania and Rhode Island. The work has been classified on the basis of the method employed and the kind of material used. Three general methods are referred to, namely, superficial treatment of roads constructed of ordinary macadam or gravel, the construction of bituminous pavements by penetration methods, and the construction of bituminous pavements by mixing methods. The bituminous materials employed have been classified in three groups: first, tars and tar-asphalt compounds; second, fluxed native asphalts, oil asphalts and residual asphaltic and semi-asphaltic oils; third, *light oils.*

The following tables give the amount in square yards of surfaces treated and bituminous pavements constructed by the State highway departments mentioned above during the years 1908, 1909 and 1910.

Superficial Treatment of Roads

	Tars and Tar-asphalt Compounds	Fluxed Native Asphalts, Oil Asphalts and Residual Asphaltic and Semi-asphaltic Oils	Light Oil
	Square Yards	Square Yards	Square Yards
1908	77 000	299 500	
1909	95 500	910 000	4 125 900
1910	183,400	2,454 900	9 890 400

Bituminous Pavements Constructed by Penetration Methods

1908	3 800	25 900	
1909	170 900	2 077 400	
1910	339 800	4 840 900	36 500

Bituminous Pavements Constructed by Mixing Methods

1908	2 100	4 400	
1909	186 000	219 500	
1910	158 000	438,600	

It is interesting to note from the standpoint of the general increase in the use of bituminous materials in the States cited that in 1908 bituminous materials were employed in the construction and maintenance of 416 000 square yards of road surface, in 1909 of 7 734 000 square yards and in 1910 of 18 244 000 square yards. Although the construction of bituminous surfaces and bituminous pavements is in its infancy in the United States, remarkable progress is being accomplished in certain sections. For instance, by the close of the construction season of 1911, if the plans of the State Highway Commission are carried out, the State of New York will have a trunk highway with a bituminous surface extending north from New York city to Albany and thence west to Buffalo, aggregating over 400 miles in length.

In the surface treatment of macadam and gravel roads several lines of development have been especially noticed: first, a more general use of refined coal gas and water gas tars in place of crude tars; second, an extraordinary increase in the various kinds of heavy asphaltic oils combined with sand, gravel or stone chips to form a carpet wearing surface; third, an increase in the use of light oils for the purpose of allaying dust on State roads, and thus to a certain extent preserving the surface of the road by the retention of the top dressing; fourth, a substitution of mechanical distributors of both the pressure spray and gravity flow type in place of hand application methods.

The practice of the past three years has amply demonstrated that the success of superficial tarring is dependent upon the recognition and adoption of those fundamental principles which were laid down by the French engineers in 1903. As those principles have not been adopted in many instances in the United States, they will be given here in brief. First, superficial tarring should be done only during dry and warm weather in order to obtain efficient and economical results; second, the road must have a dry, smooth and durable surface; third, all dust must be thoroughly brushed off in order to facilitate the adherence of the tar; fourth, after the distribution of the coat of tar it is necessary, in order to avoid a slippery surface, to apply a dressing of sand, gravel or stone chips. The practice of some prominent English engineers does not include the adoption of the fourth recommendation cited, as it is maintained that a top dressing is not an essential element of a non-slippery tarred surface.

A well-developed plan of annually treating certain roads of a system with a thin coat of bituminous material is being adopted in certain States. This practice embodies *the recognition of the fundamental principles* of economy and efficiency in modern highway construction, namely, the adaptation of method and material to local conditions.

In connection with the use of bituminous materials by penetration methods certain noteworthy tendencies are apparent. Most important are the employment of distributing apparatus and the formation of broken stone courses in such a manner as to endeavor to secure the maximum uniformity of distribution of material and the definite limitation of penetration.

The average size of stone employed varies from ½ inch or ¾ inch in longest dimensions to 1¼ inch to 1¾ inches. In exceptional cases, however, engineers have adopted the English and French practice of using larger and more uniform sizes of stone for the top course. The unfortunate delays in the application of the penetration method due to damp stone have been overcome in some instances by the employ*ment of mechanical surface heaters.*

A modification of the penetration method is known as the puddling method. The top course in this case is filled with screenings puddled by watering and thoroughly rolled. After the surface drys out it is picked up. The bituminous material is then applied, a coat of chips is spread and the surface rolled. After the surplus chips are brushed off a flush coat of bituminous material is applied. The application of another coat of chips and a final rolling completes the process.

Another modification of the regular penetration method has been employed during 1910. In this method the foundation is thoroughly filled and rolled. A layer of sand is spread upon the foundation course to a depth of about one inch. Refined tar heated to about 250 deg. F. is then applied to the coat of sand. The top course, composed of broken stone varying from ¾ inch to 2¾ inches in diameter, is spread and rolled, the lower voids being filled with the bituminous mastic. After consolidation a second coat of refined tar is applied. As soon as possible after spreading the second coat of tar a layer of stone chips is spread and rolled. A third coat of refined tar is then applied and the surface finished by rolling a covering of screenings or sand.

In the reconstruction of old roads there has been a general employment of the method of picking up the old surface to a depth of 2 inches to 4 inches by the use of mechanical scarifiers, placing a thin coat of new road metal on the loosened surface and then constructing a bituminous pavement by the penetration method.

In both the construction and reconstruction of roads by penetration methods the surface is finished in various ways. One method is to spread a coat of chips or sand after the first coat of bituminous material is applied, roll thoroughly, and after the road has set up sufficiently open it to traffic. Another method is to apply a second coat of bituminous material before the application of a layer of chips. The bituminous material *for the flush coat may or may* not be the same as used for the first coat. A layer of chips or sand is then spread over the flush coat and thoroughly rolled. A third method is essentially the same as the second method cited, except that a layer of chips is applied to the first coat of bituminous material, thoroughly rolled, and the surplus chips brushed off before the application of the flush coat of bituminous material.

From the standpoint of the character of bituminous material used it is of especial interest to note the increased use, particularly in 1909 and 1910, of fluxed natural asphalts and oil asphalts especially manufactured for application to unheated crusher run stone.

* Presented before Section D of the American Association for the Advancement of Science at the Minneapolis Meeting, December 30th, 1910, by Prof. Arthur H. Blanchard, Consulting Highway Engineer, Brown University, Providence, R. I.

In the construction of bituminous pavements by the mixing method a number of improvements and developments should be noted Some attention has been paid to having the stone dry and reasonably clean Although the advantages accruing by using clean and dry stone are recognized the practice has been far from satisfactory only very crude methods having thus far been employed The practice of heating stone on plates has been used to a certain extent with deleterious results. In a few cases mixing machines and tar coating machines have been employed in connection with the construction of bituminous pavements which are to cost not over 90 cents to $1 per square yard The types of the mixers which have been used to date are more or less unsatisfactory especially when bituminous materials are used which are solid at ordinary temperatures or which flow with considerable difficulty when cold During the season of 1911 considerable development should take place in the heating of stone by mechanical dryers and also in the use of new types of mixers especially manufactured for the purpose of mixing bituminous materials with a mineral aggregate

The mixing of broken stone or other aggregate with bituminous materials at a central plant and shipping the finished product by rail has not been developed to any extent in this country The product of one company however has been used quite extensively in three or four States In another case refined asphaltic petroleums have been mixed with sand and gravel and molded into blocks at a central plant The blocks have been laid as the wearing surface and rolled

Bituminous pavements constructed by mixing methods have been finished in different ways In certain instances satisfactory results have been attained by applying a coat of chips or sand to the surface of the course of mixed aggregate and thoroughly rolling the same In other cases a flush coat of bituminous material has been applied before the layer of mineral matter is spread over the surface The bituminous material used for the flush coat in many bituminous pavements is not the same as was used in the mix.

In the above discussion of the mixing method it should be noted that the remarks do not in general apply to bituminous pavements constructed by mixing a carefully graded aggregate and bituminous materials and hence do not refer to many types of bituminous pavements which have been used to a considerable extent in the construction of streets in municipalities.

In various parts of the United States sand gravel and earth have been mixed in place by various processes with bituminous materials in the endeavor to form an impervious dustless and durable road surface This work is being watched with considerable interest as the utilization of local materials for the aggregate in many instances reduces the cost of construction materially The limitation in the weight of traffic to be carried throughout the year under all climatic conditions is one of the most important points under discussion at the present time in connection with the above methods

A new type of construction recently introduced by Logan Waller Page director of the United States Office of Public Roads is known as oil cement concrete In this process fluid residual petroleum is added to the usual ingredients composing concrete

From the standpoint of the nature of the material used again it is noted that there is an increase in the use of refined tar considerable employment of heavy asphaltic compounds and also the employment of combinations of tar and asphalt the most noticeable increase however being in the use of heavy asphaltic oils which can be mixed readily with broken stone as it comes from the crusher

There has been a marked tendency on the part of highway engineers during the past three years to appreciate more fully the importance of the various chemical and physical properties of bituminous materials Many engineers and manufacturers now wisely advocate using different grades of the same type of bituminous material for varying local conditions and for different methods of bituminous construction During 1909 and 1910 bituminous materials for use in the construction and maintenance of road have been purchased in two ways namely by buying direct from the manufacturer a product known under a trade name and by purchasing the material under specifications The old custom of simply purchasing bituminous material under a trade name without investigation of its properties is being replaced by the second method The object of the second method has been to cover one or more of the following points first to secure uniformity in the material furnished for a given contract second to obtain a compound which conforms to certain requirements with reference to the chemical and physical properties of the material which are considered essential third to provide a standard by which it is hoped that a satisfactory material may be duplicated on other contracts The effect of the various physical and chemical properties of bituminous materials on their value as road binders is being investigated by a special committee of the American Society of Civil Engineers Standard methods of testing bituminous materials is the subject of investigation by a sub-committee of the American Society for Testing Materials

In this country as well as in Europe considerable confusion results owing to the lack of uniformity among engineers chemists and manufacturers relative to the nomenclature of bituminous materials Until a recognized nomenclature is adopted it will be advisable to define methods and materials in order to avoid misinterpretation of information furnished relative to the construction and maintenance of bituminous surfaces and bituminous pavements

Frosting, Etching, and Coloring of Incandescent Lamps

Hints for the Manufacturer and Amateur

In the *National Light Association Bulletin* the lamp committee of the association submits the following information as the result of inquiries from member companies and believing that it will be of general interest

Frosting Lamps—Frosted lamps improve lighting results by giving better diffusion and more agreeable lighting A properly frosted bulb cuts off comparatively little light averaging from three per cent to seven per cent, or from one-half to one candle power on a sixteen-candle power lamp

Lamp bulbs may be superficially frosted by dipping in a compound which any company can readily purchase from various manufacturers This frosting is not permanent however nor as satisfactory as the etched frost given to the lamps by the manufacturers which is effected either by sand blast or by acid Both processes give very similar results but for incandescent lamps the acid method is generally used

The acid method employs a solution consisting of hydrofluoric acid and carbonate of ammonium thoroughly mixed in a proportion of about ten quarts of acid to eight pounds of carbonate This is contained in a leaden vat large enough for the admission of a rack full of lamps Placed alongside the acid tub is a rinsing vat The lamps are inserted in rubber sockets in a wooden holding rack and after an initial dip in the rinsing vat to clean them they are immersed in the acid solution for about half a minute and again washed in the rinsing tub If extra heavy frosting is required lamps may be re-dipped as many times as necessary Where it is required to frost only a portion of the lamp rubber hoods are placed over the lamps to a point where the frosting is to stop The acid frost operation is dangerous and requires considerable experience in order to obtain successful results Utmost care must be used in handling the hydrofluoric acid compounds as not only will severe burns result if the solution comes in contact with the human skin but the fumes are injurious to the eyes and respiratory organs This work should be done in a specially ventilated room, and the operator should be thoroughly protected by rubber gloves and apron

Frosted lamps may be cleaned by dipping them in very hot water and rubbing them thoroughly dry with tissue paper Where this is not sufficient a little soap should be used with the hot water Tungsten lamps should always be burning while being cleaned

Etching Letters or Symbols on Lamps—The acid etching of letters or symbols on lamps is not attended with the objections and difficulties of the complete frosting process, and can be readily employed by any company to mark its lamps permanently

The question of identifying lamps as the company's property is a matter that has been given more or less attention—more particularly perhaps by the larger companies in order to protect themselves against fraud and theft of lamps especially since the advent of the metallized filament and tungsten lamps which are much more expensive than carbon filament lamps

A simple and comparatively inexpensive method which may be used by the companies rather than by the manufacturer of lamps is to etch the bulbs either with the name of the company with a letter or with a symbol

This etching is generally done on the bulb near the base and by this means the lamp may be readily identified as the etching is a permanent and positive mark which it is difficult to remove in any way

It is undesirable to have the identification marks placed on lamps by the manufacturers being necessarily expensive and when so etched the lamps become special and unsuitable for shipment to other than the one particular company It is suggested therefore to the smaller companies that should they meet with difficulty or loss in the theft of lamps the following method of identification can be adopted with comparatively small attendant cost to be used locally in their own stockroom or at any convenient point

A rubber stamp a solution of etching fluid and a heater with a perforated sheet metal top are practically all the requisites necessary for this process The heater is perforated in order that the heat may come in instant contact with the lamps and cause them to warm up quickly

A tray full of lamps is placed in this heater with the operator on one side In front of the operator are the stamps a rubber pad and a small brush with which to spread the fluid on the pad When the lamps become warm they are taken from the tray stamped and replaced as rapidly as possible When they have attained a temperature of 150 deg F the tray is removed and the operation is finished

The formula for the making of etching fluid is as follows

To one pound of ammonium fluoride crystals add thirteen ounces of fifty two per cent hydrofluoric acid and eight ounces of water Stir this solution occasionally and let it stand over night when it should be strained Then strain the clear part of the solution through medium coarse muslin Care should be taken in the selection of the ammonium fluoride crystals, which should be of fairly large size Sheet lead or hard rubber vessels should be used as containers for the etching fluid

Coloring of Lamps—Naturally colored lamps of which the glass is permanently colored are the only ones that are thoroughly weatherproof As such lamps are rather expensive superficially colored or dipped lamps are now generally employed Suitable coloring mixtures can be obtained from a number of manufacturers and the lamps can be readily dipped by any operating company In this work the old or dim lamps removed from the circuits may be used The plan generally followed is to burn the lamp in a vertical position with tip down at about two thirds or three fourths of its normal candle power When the lamps have become slightly warm take a cup of the dipping solution and raise it slowly until the lamp is submerged therein up to its base then lower slowly allowing the excess of liquid to drain off into the cup and proceed to the next lamp Lamps should be burned until the coating becomes thoroughly dry and firm

Blue green and purple are not desirable as these colors absorb so much of the light that the lamps are hardly distinguishable at a distance

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The Luminosity of the Sun

There have recently been published in France some stupendous figures with reference to the luminosity of the sun as calculated by Nordmann of the Paris Observatory

By him the solar heat is placed at 6 482 deg C The sun's total candle power is represented by him in a string of figures beginning with 18 followed by 27 noughts This inconceivable sum is equivalent to 1 994 000 for every square inch of the sun's surface Again some idea of the amount of light these figures represent may be had from the fact that the most powerful electric arc light has an illuminating power of only 20 000 candles

Prof Nordmann states that from every bit of the sun's surface the size of a finger nail there issues a quantity of light that would be sufficient to illuminate the entire Avenue de l'Opéra for a whole night In asmuch as the sun's surface is estimated to be some 200 000 000 square miles its total luminosity may be placed at 51 000 000 000 000 times that of the street mentioned

This French observer has also undertaken the task of measuring the light and heat of various large stars some of which are stated to be even more powerful illuminants than the sun For example Sirius is found by him to be about thirty times hotter than the sun i e 190 000 deg C while the Polar Star is a comparatively cold body of merely 8 200 degrees

Psychanalysis

Getting at the Facts of Mental Life

A New Field of Research

PSYCHANALYSIS is a new word which in terms comprehensible to the lay mind has been defined says *Science and Discovery* as the science of reading the inmost secrets of the heart and soul in spite of—sometimes without the least suspicion on the part of—the person who is the subject of investigation The word psychanalysis has been much used in the medical and psychological organs of late with reference to the remarkable discoveries in pathology of mental ills by the distinguished Dr Freud of Vienna But the practical application of psychanalysis as a means of getting at the facts of mental life is most indebted to Dr Jung the famed specialist in psychological therapeutics whose cures are making a sensation in Germany It has been said of him in the London *Lancet* that his cases read like reports from a new psychological world The fullest account of the Jung method is given by the able associate in psychiatry at Columbia University Dr F W Scripture There are three methods of getting at the facts of mental life explains Dr Scripture The first is that of simple observation This leads to treatment by the physician by the usual medical procedure The second method of getting at the facts of mental life is by that of experimental psychology Its aim is a most careful and accurate analysis of a patient s mental condition by tests and records This has been much exploited in lay and technical publications in late years The third method—involving medical reports from a quiet new psychological world—is that of psychanalysis

To take up Dr Scripture s exposition suppose a patient presents himself with a paresis of the right arm which began years ago There is not the slightest symptom of anything organically wrong It is evidently a hysterical paralysis Or suppose a man appears complaining that he is tortured beyond endurance by a fear that he can not perspire He never has the slightest difficulty and he knows the fear to be foolish Yet this fear is so constant and overpowering that he has been obliged to give up work Again a patient comes to the office saying that for years he has been tortured by a fear of touching filth He washes his hands a hundred times a day

Such cases are beyond the methods of observation In our own mental life there is nothing like such conditions They are so far beyond our understanding that they seem weird or incomprehensible The patient with the fear of filth told Dr Scripture that he knew it to be nonsensical and that he spent hours in discussing it with himself It is one of the great est feats of the method of phychanalysis that it has found the mental mechanism of such cases

To analyze a case of the sort recourse is had by Dr Jung to his so called association method In this a word is spoken and the patient is required to say at once what he first thought of The time taken is measured with a stop watch After a hundred such associations the patient is required to tell again what he thought of in each case Whenever the time of association is unusually long when there is evidence of forgetfulness when the patient does not respond at all to the word called out when his association is superficial—in short whenever the association is of unusual character—the word called out touched upon some topic on which the person was highly sensitive A sensitive topic in one case was an experience on the water and a record of it works out in this style

Word Spoken	Association	Time	Memory	Sensitive Topic or Compl
head	hair	1 4	x	
green	meadow	1 6	x	
water	deep	5 0	swim	'
stick	knife	1 6	x	
long	table	1 2	x	
ship	sink	3 4	steamer	'
ask	answer	1 6	x	
wool	knit	1 6	x	
obstinate	friendly	1 4	x	
lake	water	4 0	blue	'
sick	well	1 8	x	
ink	black	1 2	x	
swim	can	3 8	water	'

Applied to the man with the paretic arm the association tests showed that the words in the list where the most disturbance occurred (long time forgetfulness) were proud pure arm bird death sin The words he thought of as associations most frequently were love and like 8 times not 6 I marriage 3 arm 3 lake 3 Now just try to put these words together as a picture of his mental condition I am (or was) proud that I am (or was) pure I have sinned I would prefer death I do not love my wife (marriage) The words arm bird lake remain unexplained Nevertheless a moral catastrophe is revealed

This will be more evident to the lay mind from an other case—that of a happily married woman subject to explosions of jealousy with outbreaks of violence and of running away from the house. These out breaks she carefully concealed from the rest of the family She wreaked her temper on her husband, who was a model man In the association tests the strongest disturbances occurred with the words happiness anxiety religion choose marry part, death die In her associations she uses like 13 times man 10 child 7 necessary 7 beautiful 6 I 4

It was possible to guess the story from these results alone but it was easier to confront her with the record and show her conclusively that she has revealed something compromising to her happiness, that she is anxious about something that religious questions are troubling her The patient owned up that she was not happy with her husband that she is anxious about the future and does not know what to do that she is married outside of her religion and to a man whom she chose against the wishes of her parents and that she is debating whether she shall part with him or die

Another method of phychanalysis is that of running associations This was introduced by Freud

The patient is told to let his mind wander with perfect freedom and to tell his thoughts as they arise The method is useful in the most varied ways It must first be made clear to the patient that his cure depends upon telling the truth no matter how private may be the thought that arises he must tell it frankly to the physician

This method I will illustrate by the case reported by a clergyman of Zurich He noticed in a composition written by one of his pupils a boy of eleven years indications of strained relations among the members of the family Knowing that he could not possibly get the facts otherwise he applied a combination of the association experiment with running associations For example the word water aroused the association corpse after four seconds There after the boy associated ship a drowned person I saw how a drowned person was taken into a boat Now tell all the words that occur to you said the clergyman Bathe swimming bathhouse bottom seaweed shark earth stone springboard air chain beam submarine boat screw no air drowned What occurs to you now? asked the clergyman I saw some moving pictures with two divers that found gold One cut the air tube of the other took the gold and went up The word diver brought up the association of the dead diver in the moving pictures We could see his pale face We once got a wax mask representing a dying king with eyes turned up Arno (his brother) put on the mask and wrapped a shroud around him He looked like a ghost I was frightened The dying diver reminds me of this wax figure (meaning his brother in the mask) Over and over again the boy produces series of associations ending up in some representations of his brother as dead as in prison as tortured as murdered by him self as crucified etc It was very evident that he hated his brother from the bottom of his soul This he did not realize in the least himself The information and the treatment came through this method of psychanalysis

The method of running association is based on certain laws of the association of ideas One of these we may state as follows The oftener an idea or an element of an idea has been in mind the more frequently it will appear in associations The brother Arno was constantly in little Max s mind, no matter what he started to think about the thought of Arno would sooner or later appear Another law is that the intenser an idea is or the more motion it arouses the more often it recurs A person will remember the time he made a fool of himself no matter how much he wishes to forgot it Start any one on memory associations and he will inevitably land over and over again on the chief topics in his mind and will involuntarily deliver his secrets over to you

The more the running association is freed from the control the better the information concerning the person s mind Seat yourself in quiet and let your mind wander in associations You will notice that at each step a dozen new things crowd in together Instinctively you pick out one and proceed For example, with the word lamp there appear at once to my mind in half formed condition a certain gas flame, a certain electric light a certain proverb etc , one of these I have to catch because I cannot think clearly of all of them at the same time I catch the certain electric lamp It is in a certain room this leads my thoughts in that direction If I had caught the gas flame, my thoughts would have gone otherwise"

From childhood up we have been trained to control our thoughts to proceed in an orderly fashion to speak only in a modest way, even to think in a modest way This control becomes automatic When we let the thoughts wander we automatically catch only those thoughts that fit our training In the presence of another person we are trained to speak only in a discreet manner even to think otherwise is not proper Automatically we catch only the discreet thoughts and suppress the others. In the doctor s office the conversation is freer but even here it usually requires some training before the patient can let him self think freely

Another method is that of assigning a topic concerning which all impromptu thoughts are to be noted down For example, the physician tells the patient to note down on the spot each thought that arises impromptu concerning himself (the physician) Thus a patient reports that in an entirely impromptu manner the thought occurred to him that the doctor was getting bald On another occasion he said he thought the doctor was getting stout, and so on An entire group of these observations revolved around the signs of advancing age This was in fact the great trouble of the patient He felt that he was getting old This line of psychanalysis lets a flood of light in upon the dark places of the human soul and heart

Another patient reports that the thought had occurred to him that the doctor was extremely considerate of the feelings of his patients that he was really rather bashful, and so on This simply reflected the patient s condition of bashfulness and overanxiety about how people felt toward him Still another patient thought that the doctor must make a great deal of money out of his practice that he dressed in expensive clothes etc Of course the inference was at once clear namely that the patient s thoughts centered around money I have never had an experience quite like one that Dr Jung related to me One of his patients a clergyman told him that the thought had occurred that Dr Jung was not strictly truthful that he was not quite honorable in dealing with his patients that he did not believe that he led a strictly moral life etc Before knowing the facts of the case Dr Jung replied It is *you* who are the liar *you* have not acted honorably with your parishioners *you* are doing something immoral The thoughts that arise impromptu like this are always reflections of the patient s own personality

Nor has this new method of psychanalysis produced results less remarkable in the interpretation of dreams It seems that the dream is in reality a clue to the mental and even the physical life of far greater importance than any scientist has ever suspected or been disposed to admit For the man who tells what he has dreamed the night before is revealing did he but know it the inmost secret of his whole life

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Enlarging a Baltic Seaport.—A project for extensive engineering work for the purpose of enlarging the port of Dantzig was discussed at a recent meeting of municipal and commercial representatives of that city The matter bore upon increasing the size of the port at Neufahrwasser and the canal of the port would thus be enlarged considerably so as to reach a width of some 300 feet The outlay which is needed for this work is estimated at $500 000 to be borne two-thirds by the State and the remainder to be divided among the naval docks the municipality and the commercial interests of the city

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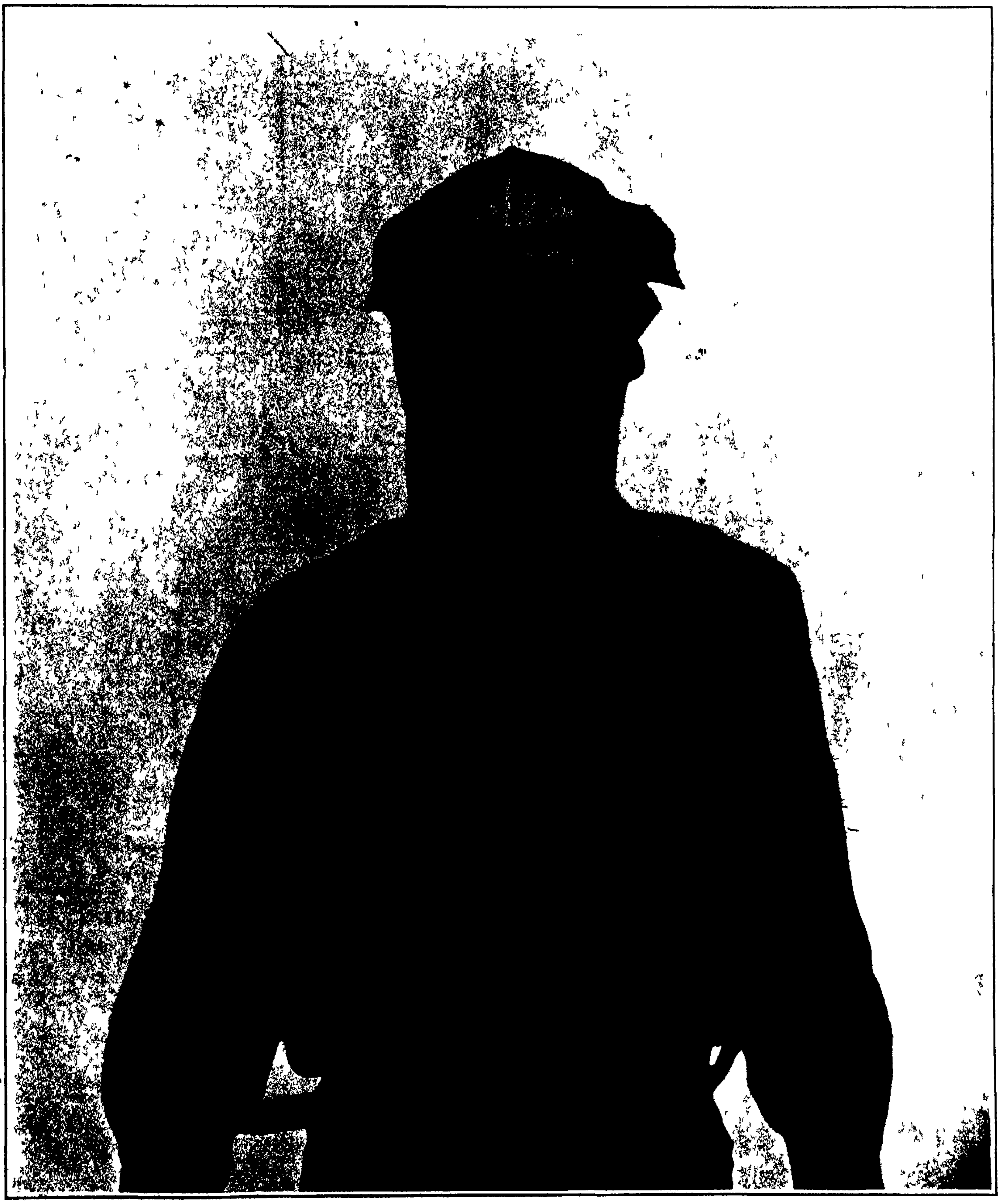


THIS MAN IS NOT A DIVER. HE IS A MINER, WHOSE HEAD IS INCASED IN AN OXYGEN HELMET SO THAT HE MAY FIGHT HIS WAY THROUGH POISONOUS GASES AND RESCUE ASPHYXIATED COMRADES

SAVING HUMAN LIFE IN MINES.—[See Page 264.]

The Discovery of Kepler's Laws

An Epoch-making Astronomical Achievement

ALMOST exactly three centuries have passed since the discovery of the laws of planetary motion. In 1609 Kepler announced that the orbit of Mars is an ellipse having the sun in one of its foci. The simple and ingenious empirical process which led Kepler inevitably to the discovery of the true form of the orbit is not generally known. This process is described by Prof. Bigourdan of the Observatory of Paris in an article in *Revue des Sciences*, which may be summarized as follows:

I. THE FIRST LAW

In the year 1600 Kepler went to Prague to assist Tycho Brahé in the construction of his new Rudolphine tables of the planets. The two great astronomers soon fell into discord, for Tycho believed that the sun revolved about the earth, while Kepler adopted the Copernican theory of a central sun. Moreover, Tycho was haughty and arrogant and Kepler was ill paid and irritable. A complete rupture was averted by the sudden death of Tycho in 1601. Kepler succeeded Tycho as astronomer royal, and Tycho's accumulated treasure of observations was placed at his disposal. Kepler continued to occupy himself with the planets and particularly with the intractable planet Mars, asserting that the secret of planetary motion must be learned from Mars or remain forever unknown. In 1609, after nine years of patient research, he published his work, De Stella Martis, in which he proclaimed the elliptical form of the orbit of Mars.

For 2,000 years the Pythagorean theory of exactly circular planetary orbits had been admitted without argument, but the earth was not placed at the center of the circle. For example, those astronomers who believed that the sun S revolved about the earth T (Fig. 1) placed the center C of the solar orbit at a distance CT from the earth. This distance, called the eccentricity, accounted for the observed unequal motion in longitude of the sun, conceived as moving uniformly in its circular orbit. A planet was supposed to move in its circular orbit, not uniformly, but with uniform angular velocity about a *punctum aequantis* E, symmetrical with T with respect to the center C.

Kepler attempted in vain to represent the motion of Mars on this hypothesis. He succeeded in reproducing the longitudes observed by Tycho Brahé, but the latitudes were in error in some cases by as much as 9 minutes of arc.

Kepler then made trial of a theory of planets including the earth revolving about a fixed sun. This new hypothesis introduced a new difficulty, for if the observations are made from a moving earth it is necessary first of all to determine the earth's motion with accuracy. This problem, very similar to that of the determination of the orbit of Mars, was attacked by a method whose simplicity attests Kepler's genius.

In Fig. 2 let T, T, T represent three positions of the earth in the unknown orbit which it describes about the fixed sun S, and let M denote another fixed point whose heliocentric coördinates are known. From these coördinates the angles MST, MST, MST_3 can be deduced, while the angles MTS, MTS, MTS can be determined by observation. Hence all the angles of the triangles MST, MST, MST_3 can be determined, and as these triangles have a common side MS, the relative lengths of the radii vectors ST, ST, ST_3 can be found. By repeating this process for various positions of the earth the form of the earth's orbit can be determined.

The point M may be any one of the planets, if the planet's period of revolution is accurately known and its position in the heavens is observed at intervals exactly equal to multiples of this period; the planet represents a fixed point, so far as these observations are concerned.

The periodic times of the planets have been known pretty accurately since the days of Hipparchus. Kepler selected to represent the fixed point M the planet Mars, whose orbit was the ultimate object of his study. This enabled him to reverse the problem and calculate SM, the radius vector of Mars, after he had constructed his tables of the earth's motion.

Among Tycho Brahé's observations of Mars, which formed the basis of Kepler's work, there was little probability of finding even a few separated by exact multiples of the period of revolution, but it was only necessary that this condition should be satisfied approximately, as the observations could be reduced to the exact epochs required by the application of small corrections which could be calculated without sensible error.

Kepler formed his tables of the earth's motion on the theory of a circular orbit and a *punctum aequantis*. From these tables he could compute the earth's radius vector ST at any epoch and could thence deduce the radius vector of Mars SM. He then tried to represent the observed positions of Mars by means of a circular orbit about an eccentrically placed sun. Three values of the radius vector, together with the values of the heliocentric longitude for the same epochs, supplied data for computing the three elements of the orbit of Mars, the radius, the eccentricity and the position of the line of apsides.

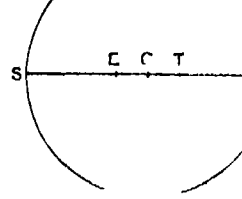


Fig. 1

These elements were already known approximately, and Kepler's results differed considerably from the known values. Furthermore, different groups of three positions gave different values of the elements. But Kepler was unwilling to abandon the old theory of a circular orbit without additional evidence.

From Tycho's observations and the old tables he determined the heliocentric longitudes of Mars at aphelion and perihelion. Then, by the empirical method indicated above, he calculated the values of the radius vector at the same epochs, i. e., the two segments of the line of apsides. Finally he assumed that the unknown orbit was symmetrically divided by that line. From these data he could calculate the radius vector at any epoch and compare it with the value obtained by the empirical method. He found

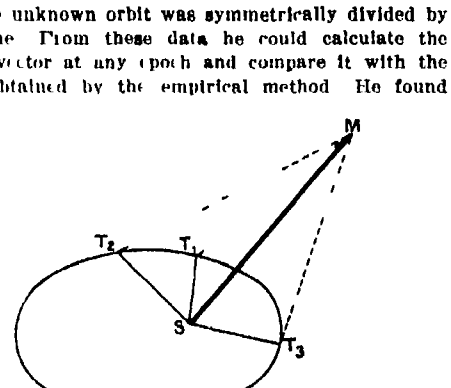


Fig. 2

that the value calculated on the theory of a circular orbit was always greater than the real or empirical value.

Kepler then definitely announced that the orbit was not circular. He at first rejected the ellipse in favor of the egg-shaped oval, but this curve likewise failed to stand the test which had eliminated the circle. At last, after long perplexity, in which he complained that his theory had gone up in smoke and that the problem would drive him mad, he found that the despised ellipse stood the test, and announced that the orbit of Mars is an ellipse having the sun in one of its foci. This is a particular case of Kepler's First

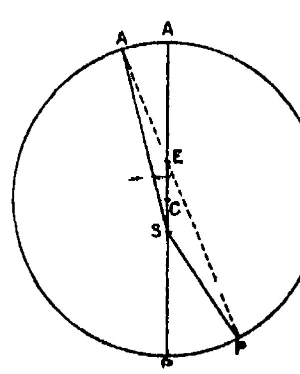


Fig. 3.

Law, which he subsequently extended to all of the planets.

II. KEPLER'S SECOND LAW

The law of the conservation of areas, which states that the radius vector of a planet describes equal areas in equal times, evidently applies to uniform motion in a circle. Kepler saw that this law also applies very approximately at and near the aphelion and perihelion of a planet moving in a circular orbit, with uniform velocity about a *punctum aequantis* E (Fig. 3) placed opposite the sun S, and equidistant with it from the center of the circle C. In the figure AA' and PP' represent arcs described, in equal short intervals of time, from the aphelion A and the perihelion P. A', E and P' lie in the same straight line by the hypothesis of uniform angular velocity about E. The areas described by the radius vector in the two equal intervals are ASA' and PSP'. Owing to the symmetrical position of E and S with respect to C, $AE = PS$ and $AS = PE$. Hence

$$\frac{ASA'}{PSP'} = \frac{\frac{1}{2}AS \times AA'}{\frac{1}{2}PS \times PP'} = \frac{AS}{PS} \times \frac{AE}{PE} = \frac{AS}{PS} \times \frac{PS}{AS} = 1$$

Having established this much, Kepler felt a moral certainty that the law of areas applied also to the ellipse, but he could not find a satisfactory demonstration of this fact until some years later.

Kepler's dedication of De Stella Martis to the Emperor Rudolph II, containing a poetical appeal for means to extend his researches to the other planets, is worth quoting in the following condensed form as an illustration of the writer's imagery and the spirit of the times:

I bring Your Majesty a noble prisoner, the fruit of a laborious and difficult war. It is not the first time he has been a captive, for long ago the terrible god of war was caught in Vulcan's net. Hitherto he has triumphed over all human devices. In vain have the astronomers employed every resource and put all their troops into the field. Mars, mocking their efforts, has shattered their engines and their hopes, retrenched himself in his impenetrable domain and concealed his movements from their spies. The valiant Captain Tycho Brahé has studied the enemy's mysterious movements almost nightly during twenty years and has bequeathed his observations to me. In the course of the war our camp has been desolated by death, pestilence and sedition. Many soldiers deserted and were replaced by raw recruits, and even the rations ran short.

At last the enemy sent his capitulation by the hand of his mother Nature. He gave his parole and Arithmetic and Geometry escorted him to our camp. He has since proved that his parole can be trusted, and he asks but one favor from Your Majesty. His father Jupiter, his grandfather Saturn, his brother Mercury and his sister Venus are still in the sky. He pines for their society and longs to see them also enjoying your hospitality. For this purpose the war must be prosecuted with vigor, but money is the sinews of war, wherefore I beseech Your Majesty for the funds required for the levy of fresh troops.

III. KEPLER'S THIRD LAW

The Third Law was not discovered until 1618, after twenty-two years of research and speculation. In the Mysterium Cosmographicum, published in 1596, Kepler writes:

"I propose to show that God, in creating the universe and arranging the spheres, had in view the five regular solids of geometry, and fixed by their dimensions the number, proportions and motions of the spheres. Take the sphere of the earth as a unit and circumscribe it with a regular dodecahedron. The sphere that contains this dodecahedron is the sphere of Mars."

The spheres of Mars and Jupiter, Kepler continues, are similarly related to a regular tetrahedron described about the former and within the latter, those of Jupiter and Saturn to a cube, those of Venus and the earth to an icosahedron, and those of Mercury and Venus to an octahedron. Kepler in this early work compares the distances of the planets from the sun derived from this geometrical system with the distances given by Copernicus, and finds that Jupiter alone presents a serious discrepancy, which he attributes to the inaccuracy of the value given by Copernicus. Kepler was satisfied with the result, although he could not then find a simple law connecting the distances of the planets.

He returns to the subject in the Harmonices Mundi, a work in five volumes, published in 1619, in which he discusses polygons, the five regular solids, astrology, politics, the faculties of the mind and other things. He revives the Pythagorean analogy between music and the harmony of spheres, and calls Saturn and Jupiter the bass voices, Mars the tenor, Venus the contralto and Mercury the soprano or falsetto of the celestial choir.

From this chaos of dreams emerges Kepler's Third Law, which is thus formulated:

"The proportion between the periodic times of two planets is exactly equal to the sesquialterate ratio of their mean distances from the sun." The sesquialterate ratio is the ratio of the 3-2 powers. In

other words, the squares of the periodic times are proportional to the cubes of the mean distances, as the Third Law is usually expressed. Contrary to his wont, Kepler does not give the history of this discovery, but the work terminates with the following famous passage:

"Eight months ago I saw the first ray of light; three months ago I saw the dawn; three days ago I saw the sun in his splendor. I give myself up to enthusiasm. I voluntarily defy mankind with the ingenious confession that I have stolen the golden vase of the Egyptians to make of it a tabernacle to my God far from the bounds of Egypt. If you pardon me I shall rejoice; if you reproach me I shall endure it. The die is cast. I have written my book. It will be read by the present generation or by posterity; it matters not. It can await its reader. Has not God waited six thousand years for a contemplator of his works?" He concludes with a prayer of thanksgiving to the Creator.

Thus were established Kepler's three laws of planetary motion which led Newton to the discovery of universal gravitation, the basis of modern astronomy.

Preparation of Pure Radium Salts*

The Process of Fractionation Employed

By Madame Curie

To effect the separation of pure radium chloride from the barium chloride with which it is associated I have subjected the mixed chlorides to a fractional crystallization first from pure water and then from water acidulated with hydrochloric acid. This process is based upon the fact that radium chloride is less soluble than barium chloride.

A saturated solution of the chlorides in pure distilled water at boiling temperature is prepared and is left to crystallize in a covered vessel. After cooling a deposit of fine crystals is found upon the bottom of the crystallizing vessel, and the supernatant solution can be readily poured off. If a sample of the mother liquor is evaporated to dryness and the residues tested it is found to be five times less active than the portion originally crystallized out. In this way the chlorides are separated into two portions A and B or which A is much more active than B. The operation is now repeated with each of these parts thus again obtaining from each a further crop of two parts. The less active portion obtained from A is then united with the more active portion obtained from B, these two portions having approximately the same activity. The result of this step is three fractions which are once more subjected to the operation described. The number of fractions thus prepared is not allowed to increase indefinitely for as the process goes on the activity of the soluble portion becomes less and less. When it has sunk to an insignificant value the particular portion is eliminated from the process. After a suitable number of fractionations the most difficultly soluble portion which is richest in radium is also withdrawn from the operation.

A fixed number of fractions is maintained. After a series of crystallization the saturated solution of one fraction is united with the crystals of the next following fraction. When however the most readily soluble fraction is discarded at the end of a series a new readily soluble fraction is prepared in the next series and the most active crop of crystals is taken out of the process. By systematically following out this scheme a very regular mechanism of fractionation is obtained, the number of fractions and the activity of each fraction remaining constant, each being about five times as active as the next lower in order. At the one end an almost inactive product is discarded and at the other end a chloride enriched in radium is collected. The total quantity of material diminishes continually and the several fractions become smaller and smaller as their activity increases. The work is begun with six fractions and the activity of the chloride discarded at the end is only one-tenth that of uranium.

The accompanying diagram represents the scheme of such a fractionation. Each point represents a crop of crystals from the portion indicated by the affixed numeral. The two arrows extending from a given point indicate the two products crystals and mother liquor resulting from each crystallization, e. g. to the left, crystal; to the right, mother liquor. Where two arrows converge to a point this indicates the union of the crystals separating from one portion with the solution from the immediately preceding portion. The outwardly directed arrows signify that the final product has been removed from the fractionating process.

When a large proportion of the inactive substance has been in this way eliminated, and the quantity of material has consequently been much reduced it is no longer worth while to separate out these portions at such low activity. The last members in the series are then discarded and are replaced from above by previously collected active chloride with the effect that a chloride richer in radium is precipitated than at first. This is continued until the crystal crops at the beginning of the series represent pure radium chloride. If the fractionation has been carried out perfectly, the amount of intermediate products left over will be very small.

When, in the course of the fractionation, the bulk of the individual fractions has been much reduced the separation by crystallization becomes less effective because the solutions cool off too rapidly and the volume of the mother liquor decanted off becomes too small. At this stage it is advantageous to add a definite amount of hydrochloric acid to the water used for dissolving, gradually increasing the amount of acid so added as the fractionation proceeds. This addition has the advantage that the volume of the solution is thereby increased owing to the fact that the chlorides are less soluble in dilute hydrochloric acid than in pure water. At the same time the fractionation becomes more thorough, the difference between the fractions separated from a given stock is increased. If the acid is added in considerable concentration a very excellent separation is obtained and the fractionations may be reduced to three or four. It is therefore a great advantage to begin with the addition of hydrochloric acid just as soon as the diminished amount of material permits this step to be taken without inconvenience.

The crystals which separate out from strongly acid solutions are long and needle-shaped and identical in appearance whether they be barium chloride or radium chloride. Both these are doubly refractive. The crystals of the barium chloride containing radium are colorless. If however the radium content reaches a certain limit the crystals assume after standing for several hours a yellow color ranging toward orange or sometimes a fine rose tint. This color disappears on dissolution. The crystals of pure radium chloride do not become colored in this way or at least not as rapidly so that the coloration appears to be dependent upon the simultaneous presence of radium and barium. The maximum coloration occurs when the amount of radium assumes a certain definite proportion and this furnishes a means of gaging the progress of the fractionation. So long as the most active fraction becomes colored we know that it still contains a considerable amount of barium. If it no longer becomes colored on standing while the fractions of lower order do, then the colorless portion is approximately pure radium chloride.

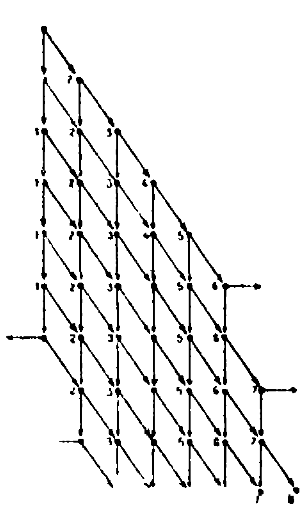


DIAGRAM INDICATING THE SCHEME OF SUCCESSIVE FRACTIONAL PRECIPITATIONS

I have sometimes observed crops of crystals which consisted partly of colorless crystals and partly of others which became colored upon standing. Perhaps they might have been separated by picking them out individually but this was not attempted.

Toward the end of the fractionation the successive fractions no longer display the same relative activity nor is the proportion of their activity as regular as at the beginning of the process; this however does not cause any serious disturbance in the progress of the fractionation.

In working up a few kilograms of the chlorides obtained from a ton or more of the residues used as raw materials, it is necessary to modify somewhat the mode of procedure. The first fractionation is in this case carried out at the factory, so that after eliminating ninety per cent of the barium salt a product enriched in radium can be delivered from the factory. This first fractionation requires comparatively large volumes of the saturated solutions and is carried out in cast iron kettles. In place of distilled water rain water or river water as poor in dissolved salts as possible is used from which all sulphates have been carefully precipitated by the addition of a small excess of barium chloride.

The separation of radium can also be carried out by the fractional precipitation with alcohol of an aqueous solution of the barium chloride containing radium. I used this method at first but subsequently abandoned it in favor of the one described above which assures greater uniformity. At times however I have made use of the precipitation by alcohol to purify radium chloride containing a small amount of barium chloride admixed with it. The latter remains dissolved in the slightly diluted alcohol and can be thus removed.

Giesel who has been occupied with the preparation of radioactive bodies since the publication of our first investigations recommends for the separation of barium and radium the fractional crystallization of the mixed bromides from an aqueous solution. I have found that this method is very advantageous especially at the beginning of the fractionation. This however is the case only if the amount of salts to be fractionated is not too large. If there are several kilograms to be treated the use of a corresponding amount of hydrobromic acid becomes objectionable partly on account of its high price and also because the cast iron kettles are more easily attacked by the bromides than by the chlorides. Nevertheless it is advantageous to convert into bromides the chlorides obtained from the first fractionation as carried out in the factory which are greatly reduced in bulk as compared with the original raw material. In this way a more rapid fractionation is secured so long as the quantity of material is not too greatly reduced. When however the amount of the salt is quite small working with the bromides is less satisfactory than with the chlorides owing to the fact that the former are on the one hand much more soluble and on the other hand much more subject to change than the latter. A solution of the bromide very rich in radium in water or dilute hydrobromic acid undergoes very rapid alteration with liberation of bromide. For this reason it is in my opinion advantageous to convert salts of high radium content into chlorides in preparing a pure and stable radium salt. In the dry state the chloride is more sharply defined and more stable than the bromide and does not undergo any appreciable spontaneous change.

Whatever process of fractionation is employed it is always useful to control the course of the process by measuring the activity of the product.

It should be emphasized that a radium compound which has been prepared in the solid form either by crystallizing or precipitating from a solution does not have a constant activity from the start. The activity increases for about one month to a limiting value which thereafter remains constant. The final activity is five or six times as great as the initial activity. These changes must be taken into account in measuring activity. The final activity is more clearly defined but in the course of chemical operations upon radium salts it is more practical to measure the initial activity of the solid product.

While the salt submitted to fractionation has of course always undergone a previous purification it is nevertheless often desirable to purify once more a salt of high radium content. The fractionation itself of course effects a certain purification inasmuch as traces of the salts which are very readily soluble in acidulated water (e. g. those of calcium, iron and magnesium, etc.) are eliminated. On the other hand however traces of lead chloride or bromide accumulate with the radium salt in the difficultly soluble portions. For this reason it is generally speaking necessary to treat the salts of very high radium content with hydrogen sulphide before proceeding to the final elimination of the barium.

* Extract from a work entitled "Traité de Radioactivité." Translated for the SCIENTIFIC AMERICAN.

International Standard Time

Its History and Its Recent Adoption in France

The French Senate recently passed a law which was passed by the Chamber of Deputies fourteen years ago and which will make the legal standard time in France 9 minutes and 21 seconds slower than Paris mean solar time which is the present French standard The reason for selecting this interval of 9 minutes and 21 seconds the reservations by which a complete and formal adoption of the meridian of Greenwich has been evaded and the advantages and disadvantages of the change are discussed in *La Revue des Sciences* by Prof Bigourdan of the Observatory of Paris Prof Bigourdan's article an abstract of which is here presented also contains an outline of the history of international standard time

Every place on the earth's surface has its own local time and the difference between the local times of any two places is proportional to the difference of their longitudes one hour corresponding to 15 degrees or 4 minutes to 1 degree of longitude When the stage-coach was the most rapid means of travel the difference in local time caused no great inconvenience but the development of the railway soon made it necessary to adopt a single standard of time for all the stations of a line or even of a country The local time of Paris was naturally selected as the standard of railway time throughout France but the local times of other places long continued in use for local purposes The difference between local and railway time varied according to the distance east or west of Paris Local time was 20 minutes faster than railway time at Nice on the eastern frontier and 27 minutes slower than railway time at Brest on the western frontier The local time gradually lost importance and the railway or Paris time gained until in 1891 the passage of the law which made Paris time the legal standard for all France and Algeria was scarcely noticed by the public The same practical conditions led to the enactment of similar laws in other countries each of which as a rule adopted the local time of its principal astronomical observatory

This simplification however produced remarkable diversities of time standards in some regions The Lake of Constance for example is bounded by five countries Switzerland Baden Wurtemberg, Bavaria and Austria—each of which had its separate national time standard The confusion thus created in railway and steamboat time tables and in the minds of travelers may be imagined In going from Paris to Constantinople a traveler was compelled to set his watch ten times

These inconveniences suggested the adoption of a single time standard for all countries but the impracticability of this idea is evident from the obvious fact that a single standard is inadequate for one country of great extent in longitude The United States for example covers five hours in longitude and the winter sun is rising on the Pacific coast when it is noon on the Atlantic coast The adoption of a single standard for the whole world would produce an intolerable displacement of traditional hours in most places and though the Japanese are ardent lovers of science and progress it is not to be supposed that they would consent to have the sun set at 9 o'clock in the morning It should be added, however that the advocates of a universal time stand ard limited its employment to railways steamship lines mails telegraph systems and similar uses

The question of a universal time standard is necessarily connected with that of an international prime meridian and the two questions were discussed together at the geographical congress which met in Venice in 1881 at the meeting of the International Geodetic Association in Rome in 1883 and elsewhere

Geographers have always felt the necessity of reckoning all longitudes from a single meridian but the location of this prime meridian is arbitrary and has varied greatly In the 17th century Richelieu selected the meridian of Ferro the most westerly of the Canary Islands and the most westerly land known to the ancients The meridian of Ferro was for a long time accepted almost universally as the prime meridian but as its longitude was not accurately known it was arbitrarily assumed, at the suggestion of the celebrated geographer Delisle to be 20 degrees west of Paris This assumption made the meridian of Paris the real prime meridian and in course of time each of the great nations adopted the meridian of its principal astronomical observatory as a prime meridian

When the return to a single prime meridian was discussed at the congresses of Venice and Rome it was agreed that this meridian must pass through an observatory of the first class situated in a region free from volcanic and other disturbances The choice was practically limited to the meridians of Greenwich and Paris

The latter had played a most important part in the 18th century in connection with the numerous expeditions sent out by the Paris Academy of Sciences for the determination of longitudes in Denmark Cayenne Senegambia the West Indies Siam China Cape Colony etc which resulted in the correction of errors amounting in some instances to 27 degrees In the expedition to Cayenne Richer made the memorable discovery of the shortening of the seconds pendulum in approaching the equator The exact measurements instituted by Picard and based on the meridian of Paris were extended from France to the Arctic circle, the equator and the Cape of Good Hope In short, geodesy continued for a century to be an exclusively French science

Subsequently the meridian of Greenwich gained importance chiefly in the determination of longitudes by the moon and nine tenths of the mariners of the world use English charts in which longitudes are reckoned from Greenwich The Rome congress of 1883 consequently decided in favor of Greenwich and this choice was confirmed by the international conference held in Washington a year later

The Canadian Institute had already proposed to divide the earth's surface into 24 sections each embracing 15 degrees of longitude and to employ in each section a time standard differing by one hour from those of the adjacent sections. This system was adopted in 1883 by the American railways, and has since been adopted for general use in America and Europe It is illustrated by the accompanying map. The prime meridian of Greenwich is represented by the doted line, marked 0 degrees. The hour section marked 0 at the bottom of the map is bounded by two meridians drawn 7½ degrees east and west of the prime meridian The hour section marked 1 extends 7½ degrees east and west of its central meridian (not drawn) which is 15 degrees east of Greenwich and so on Each country which has adopted the system uses as its time standard the time of the hour section to which its territory most nearly corresponds or if it extends over several hour sections employs several standards, determined by the same rule, for its various political divisions

This system possesses most of the merits and none of the defects of a single universal time standard, for local time never differs from standard time by much more than half an hour and the standard times of any two places or countries differ by a whole number of hours, the minutes and seconds being everywhere the same The figures at the bottom of the map mark the hour of each section when it is midnight at Greenwich (The numbers of the left hand half indicate afternoon hours and must be diminished by 12 to agree with the clocks used in most countries) Special names have been given to the most important hour sections as follows

Name	Section	Time
West European	0	12 P M.
Mid European	1	1 A M.
East European	2	2 A M
Pacific	16	4 P M.
Mountain	17	5 P M.
Central	18	6 P M
Eastern	19	7 P M
Intercolonial	20	8 P M

France is included almost entirely in the section of West European or Greenwich time which is 9 minutes and 21 seconds slower than Paris time

The difference between the longitudes of two places can be obtained either by linear measurement and triangulation or by determining the difference between their local mean times by astronomical observations The difference in longitude of the observatories of Paris and Greenwich has been repeatedly determined by each of these methods which often give discordant results In the present case in which the difference in time is the real object of search the results obtained by the second method are naturally adopted Accurate determinations of this kind have been possible only since the introduction of the electric telegraph The results obtained by various observers since 1854 are given below

		Min	Sec
1854	Donkin and Faye	9	20 51
1872	Coast Survey	9	20 97
1888	Lewis and Turner	9	20 85
1892	Hollis and Turner	9	20 79
1902	Dyson and Hollis	9	20 93
1902	Bigourdan and Lancelin	9	20 99

The value 9 minutes 21 seconds is sufficiently accurate for practical purposes

The law recently created contains only one article, which reads The legal time in France and Algeria is nine minutes and twenty one seconds slower than Paris mean time In this form the law was passed by the Chamber of Deputies in 1897 and by the Senate in 1911 In the original form of the bill introduced in the Chamber of Deputies in 1896 the meridian of Greenwich was explicitly adopted The change was made in, order to prevent sinister interpretations which might have killed the bill

The question of the meridian is left untouched by the new law which applies only to railways, mails and civil affairs in general The meridian of Paris remains the standard for the navy merchant marine astronomers and geographers and more than 3,000 official maps and 600 volumes of nautical instructions remain unchanged

The change brings unquestionable advantages in connecting French with foreign railway and telegraph schedules and meteorological bulletins and terminates the complete isolation of France in respect to time standards On the other hand, it presents the slight disadvantage of substituting for the meridian of Paris, which divides the country almost equally a meridian lying much farther westward But the difference between local and standard time will not be much greater at Nice than it was formerly at Brest.

The national *amour propre* has been wounded severely, especially as the meridian of Paris was the only one that could pretend to challenge the supremacy of Greenwich, but the French may console themselves with the thought that the new time is not English but international, and, furthermore, that it is ingeniously defined by the law as "nine minutes and twenty-one seconds slower than Paris mean time."

MAP OF THE WORLD DIVIDED INTO HOUR SECTIONS

The Air-brake as Related to Progress in Locomotion—IV*

The History of a Great Invention

By Walter V Turner, Chief Engineer, Westinghouse Air Brake Co, Pittsburg, Pa

Concluded from Supplement No 1842, page 246

STARTING AND STOPPING

THE problems of deceleration retardation and the flexible control of trains must receive more and more attention from a scientific and technical standpoint in order that to-day theory and practice may be combined to produce the best results in the shortest time This is necessary if the brake is to efficiently and satisfactorily meet the wonderfully changed conditions which have developed since the invention of the quick action automatic brake The high speeds and great weights of the present day requiring that advantage be taken of every opportunity offered to increase and flexibly control braking power

Starting and stopping of trains are complementary factors in the problem of making time between stations therefore it is evident that the best results can only be obtained where both factors are given due consideration Generally the starting factor is the only one fully considered or at least the one more fully provided for and this notwithstanding that better results can be obtained if both are considered and the more efficient brake system installed

In another sense the question of stopping is the most important as the safety of the service and the freedom of delays to a great degree depend upon it The measure of the value of the brake is two fold—(1) the ability to stop in the shortest possible distance when necessary and (2) to permit short smooth and accurate stops being made in regular operation Therefore both these factors should be considered when design is under way

Unfortunately the brake is usually looked upon as a safety device only and it is because of the prevalence of this idea that its installation and maintenance do not receive the consideration merited Considering the investment, there is no part of the railway equipment that will give greater material returns than the brake when properly installed operated and maintained If the brake could to some extent be separated from the idea or impression that it is a safety device only and proof advanced to show that it makes possible the hauling of heavier cars—in fact makes the heavy car possible—that it makes possible faster and more frequent service—as much or more than does the locomotive the block signal and the good roadbed—and that if given the consideration it should have it would increase the possibilities profits and value of all these things—its importance would be more fully appreciated and therefore at least the same consideration be given to its design and installation that is accorded to other parts of railway equipment A safety device the brake is *par excellence* but it has other reasons for its existence

Very few perhaps realize that the brake under a single car is much more powerful than the locomotive that pulls the train yet this will be apparent to any who examines the records of a dynamometer car stop the train The comparison is somewhat startling but it is only because the condition is one of those commonplaces which have been taken for granted so long that they are accepted as inherent rather than being given the degree of consideration which their significance warrants Fig 22 is an illustration of the facts stated taken from the records of a run during a series of tests at Absecon N J 1907 the train being composed of a locomotive and ten cars What it took the locomotive nearly six minutes and a distance of about three and a half miles to accomplish was overcome by the brakes in less than twenty seconds and within a distance of about one thousand feet The broken line represents what the stop might have been if no brakes had been used i e the train brought to rest by the resistance of the air and journal friction All the elements so strongly contrasted in Fig 22 are familiar in themselves but their reciprocal relationship is often overlooked The average passenger train of to day can be stopped from a speed of sixty miles per hour in about twenty seconds time To build a steam locomotive that would accelerate a train in the time and distance

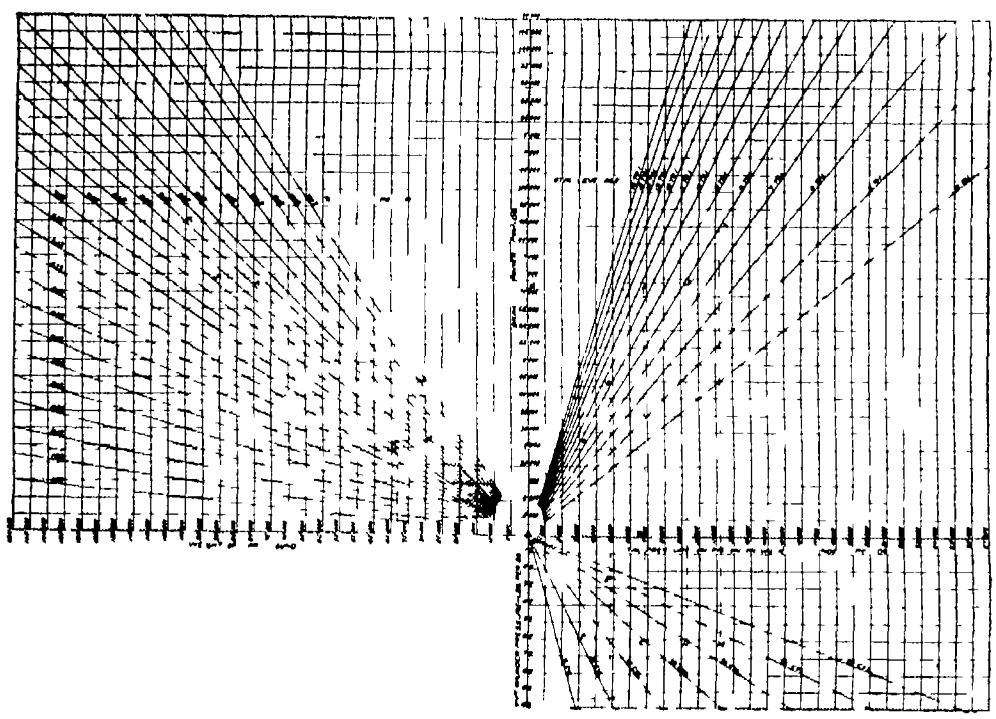
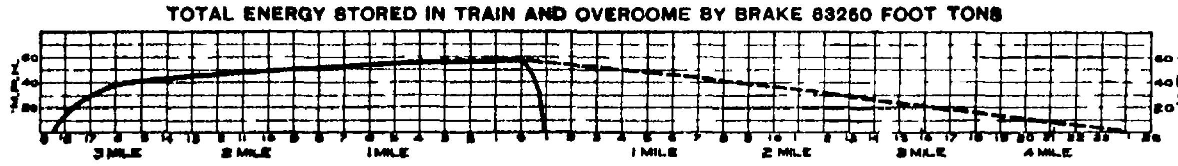


FIG 23 CHART SHOWING RELATION BETWEEN SIZE OF BRAKE CYLINDER BRAKE-CYLINDER PRESSURE TOTAL LEVERAGE RATIO BRAKING POWER AND WEIGHT OF CAR

CLASS E-2 D LOCOMOTIVE.
TOTAL WEIGHT OF TRAIN 559 6 TONS
ACCELERATION DISTANCE OF 18500 FEET
TIME OF ACCELERATION 5 MIN 47 SEC
DECELERATION DISTANCE OF 954 FEET
TIME OF DECELERATION 18.7 SEC

TOTAL ENERGY STORED IN TRAIN AND OVERCOME BY BRAKE 83260 FOOT TONS



BROKEN LINE REPRESENTS STOP WITHOUT THE USE OF BRAKES.

NOTE: THE CALCULATED STOP WITHOUT BRAKES WAS OBTAINED BY ASSUMING 8.8 POUNDS PER TON RETARDATION DUE TO WIND RESISTANCE AND JOURNAL FRICTION. TRACK LEVEL.

FIG 22—ACCELERATION AND DECELERATION CURVES ABSECON N J TESTS

alone attached to an engine the stops being made by brakes on the dynamometer car Few realize that it takes a locomotive perhaps five minutes perhaps ten minutes, and a distance of some miles—six or seven—to attain a speed of sixty miles per hour Imagine the condition of affairs which would exist if it took a brake that length of time and distance to that the brake stops it would be impossible for in order to have the necessary adhesion to the rails which permit of developing the required drawbar pull the steam locomotive would have to weigh approximately twice as much as the train itself which is of course prohibitive Electric locomotives however are no longer to be regarded with uncertainty or as mere experiments, and there is every reason to believe that the electric locomotive will be able to accelerate a train to a speed of sixty miles an hour in certainly not more than a minute and a half and probably not more than one minute's time That means that the brake is going to be even more important in the future than it has been in the past In proportion as we accelerate we must perforce be prepared to decelerate The ability to accelerate or even to run at high speeds must be measured by the ability to stop

As an example however of how little this is appreciated such a question as the following is often asked and a categorical answer apparently expected In what distance should a train be stopped from a speed of fifty miles per hour? Perfectly simple isn't it? Here we have one known factor from which we are expected apparently to derive all the other factors which are of equal importance and must be known before an answer of any value can be given to such a question A few of these factors are The light weights and loads of the vehicles composing the train the percentage of braking power used with engine and cars whether or not all wheels including truck and trailer (if any) of the locomotive were braked what type of brake equipment was used what pressures were carried whether the train was accelerating or decelerating on a curved or straight track on an ascending or descending grade or level the condition of the rail whether the brakes were applied in service or emergency or ordinary service and then emergency the piston travel on each vehicle the losses to friction of parts brake beam release springs, etc Wind resistance, quality and thickness

* Presented at the meeting of the Mechanical and Engineering Section.

of brake shoes and method of hanging them, for this affects materially the efficiency of the brake both as to absorbing power and lengthening the piston travel which reduces the pressure otherwise obtainable. Furthermore it should by no means be understood that the precise effect of each of these could be accurately calculated even though full information were at hand and a little thought will make it evident that each of the factors mentioned above may have a considerable influence on the length of the stop.

These things are merely mentioned to emphasize the great importance of the air brake and the necessity for considering carefully what principles govern its action. It does not make very much noise. It does not occupy so prominent a place in the papers as electricity, for instance, yet it has been much more of a factor in railroad development up to the present time than electricity.

Now from a comparison between the propelling and stopping mechanism of our steam railroads. The locomotive is much in evidence, being large and of powerful appearance and placed in the most conspicuous place in the train. The brake is outwardly a comparatively insignificant piece of apparatus installed on the different vehicles of the train, placed underneath the cars where it is hard to find and seldom observed by the traveler. The very fact that it is so distributed over the train is one reason for its power and efficiency. When we realize the forces handled by the two devices and the great difference in point of time in which their work is accomplished our respect for the brake will be stimulated since it *must* be capable of dissipating the energy stored by the locomotive in the train in but a fraction of the time required by the locomotive to do this if the safety of transportation is to be preserved.

FUNDAMENTAL PRINCIPLES IN BRAKE DESIGN

In the establishment of a logical basis of brake design applicable to the conditions under which brakes in general must operate and involving a determination of the essential elements of an elementary brake system for any given car the starting point must be the light weight of the car. Fortunately this can usually be determined in advance to any desired degree of accuracy. For convenience suppose the car to be fully equipped with a complete brake equipment and by an analysis of the factors involved in stopping the car determine how these factors may best be provided for in the design.

Assuming that the wheels do not skid the actual *braking force* acting on a car when the brakes are applied is the force of the friction between the brake shoes and the wheels tending to retard the rotation of the wheels and thus stop the car. The relation which this bears to the energy stored up in the moving car, provided the adhesion of the wheel to the rail is not exceeded, determines the effectiveness of the brake and the length and time of stop. The energy of the moving car consists of two parts—that of the car as a whole due to the velocity of translation and that of the revolving wheels due to their rotation and varies as the weight of the car and as the square of its velocity.

The latter may roughly be taken as 5 per cent of the energy of translation for 12-wheel cars and as 2 per cent of the energy of translation for 8-wheel cars. In ordinary calculations however this factor is usually neglected and properly so because for modern rolling stock the resistances other than as derived from the brakes, such as internal friction, air resistances, flange friction and so on has been shown by actual experiment to at least equal if not to exceed the inertia effect of the revolving parts. Consequently a greater error is made by considering the energy of rotation without at the same time taking into account the resistances to motion which exist due to other causes than the brake shoes (which it should be noted are usually indeterminate and subject to considerable variation) than to assume that these two opposing factors neutralize each other.

The frictional force between the brake shoes and wheels depends on the pressure acting on the shoes and the coefficient of friction between the shoes and the wheels. In making a stop therefore (it being assumed throughout that the wheels do not skid) the factors involved so far as retarding the rotation of the wheels is concerned are:

1. The total amount of brake-shoe pressure in pounds commonly called the "braking power."
2. Coefficient of friction between the shoes and the wheels by which the brake-shoe pressure must be multiplied in order to determine the actual retarding force.
3. The weight resting on the wheels.
4. The velocity of the car.
5. The rotative energy of the wheels.

Only one of these factors can be controlled even partially in service or fixed arbitrarily in designing the brake system, viz. the pressure on the brake shoes. Inasmuch as the wheels must not skid when the weight resting on the wheels is least—that is when the car is not loaded—the light weight of the car must be taken as the basis of calculation regarding brake-shoe pressure, except in the case of some form of empty and load brake. Since the "braking power" is by custom measured by a scale of percentages wherein 100 per cent represents a shoe pressure on each wheel equal to that wheel's pressure on the rail the problem is then to determine and insure the obtaining of the proper relation between the brake shoe pressure and the light weight of the car.

As pointed out above the factors involved such as frictional coefficient, speed, weights, etc. are so subject to variation in service that no theoretical conditions can determine the proper nominal percentage braking power (i. e. the ratio of brake-shoe pressure to light weight of car) which shall best meet average road conditions. This can be fixed only by experiment and experience and is subject to modifications as conditions change or become more thoroughly understood. For example many years experience has proven that 90 per cent braking power for passenger cars gives satisfactory braking effects with a reasonable margin against wheel sliding and sufficient power for service stops. This was determined by the results obtained on the lightest cars. So far as wheel sliding is concerned a 150,000 pound car braked at 95½ per cent has practically the same margin against wheel sliding as a 70,000 pound car braked at 90 per cent. But if the percentage of braking power is varied the uniformity of service braking effect other factors being the same is lost. *Therefore the percentage of braking power determined as a satisfactory maximum for the lightest cars* must be adhered to on all cars in order to bring about as nearly as possible the uniform results which are necessary for satisfactory service operation.

Having therefore chosen a certain percentage of braking power which should be obtained on all cars it is evident that what actually is obtained in any given instance depends on the total leverage ratio and the pressure per square inch on the brake piston. It will be apparent that all resistances between the brake piston and brake shoes such as release springs, reactions of hanger links, friction of rigging, etc. must necessarily be ignored until the essential factors in the design are determined upon.

The total leverage ratio is fixed within certain limits by purely mechanical consideration with regard to piston travel, shoe clearances, etc. and once the foundation brake rigging is designed remains always the same.

Hence in any given case the percentage of braking power actually obtained depends entirely on the pressure existing in the brake cylinder which varies in practice from zero to the maximum obtained when an emergency application is made.

In designing the brake system for a car therefore the leverage ratio and size of brake cylinder must be so proportioned as to give the required braking power in pounds with some arbitrarily chosen pressure in the brake cylinder. Evidently this braking power will be obtained in practice when the brake-cylinder pressure is that on which the design of the brake system was based. For any pressure lower or higher than this the braking power in pounds will be correspondingly lower or higher than the nominal. Furthermore the actual percentage of braking power (ratio of brake shoe pressure to weight on wheels) varies not only with the brake cylinder pressure but also with the condition of the car—whether loaded or empty.

From a consideration of these conditions it seems evident that it is practically impossible to provide for even an approximate uniformity of brake action on different cars in service by any method of design. The best that can be done is to establish and adhere strictly to the assumed standards upon which such designs are based.

1. The percentage of braking power in terms of the light weight of the car.
2. The brake-cylinder pressure upon which this percentage is based.

The former as has already been stated must be determined from experiment and experience. The latter must be chosen arbitrarily but it should have the same value for all brake calculations in order to insure a common base being universally used and understood. Fig. 23 graphically illustrates the relations existing between these two factors for different weights of cars and total leverage ratios. The question now is therefore: What brake-cylinder pressure should be used as a basis in designing the brake systems of all types and classes of cars?

With a given auxiliary reservoir charged to a standard pressure and with a given brake cylinder having standard piston travel a certain definite pressure of equalization is obtained which is constant so long as the other factors involved are kept constant.

When an emergency application is made, since a portion of the air in the brake pipe or other source of supply is used in addition to that in the auxiliary reservoir, the resulting brake-cylinder pressure is augmented in proportion, and a higher maximum pressure therefore obtained. Evidently its value must depend upon the relation which the supplementary brake-pipe volume bears to that of the auxiliary reservoir and brake cylinder combined. With equipments now in general use this ratio must necessarily decrease as the size of the car increases because the brake pipe volume remains practically constant for all sizes of cars while the brake-cylinder and auxiliary reservoir volumes increase as the size of the car increases. It then follows that where air from the brake pipe alone is used to augment the brake-cylinder pressure in emergency applications, the emergency pressure thus obtained must vary with the different combinations of auxiliary reservoir and brake cylinder necessary for different sizes of cars—the gain in pressure from this source over that obtained in full service equalization being greatest with the smallest sizes of auxiliary reservoirs and brake cylinders.

Hence in choosing a brake-cylinder pressure on which to base brake calculations that obtained in emergency which was satisfactory where the brake cylinders were of such size that a uniform pressure was obtained in both service and emergency, is now excluded at the outset—from the standpoint of uniformity—since in the nature of the case it is not uniform for all weights of cars. This is for the reason that brake cylinders may vary from 6 inches to 18 inches diameter with correspondingly varying pressures in emergency. And if the braking power desired is based on a brake-cylinder pressure higher than can actually be obtained then for lower cylinder pressures the brake is not so effective as it might be made were the braking power based on the pressure actually obtained. The smaller cars which do obtain this pressure give the calculated braking power in emergency but the heavier cars cannot, and there is a loss both in uniformity of emergency action and possible efficiency.

On the other hand for brake-pipe reductions less than sufficient to produce equalization the cylinder pressures obtained are uniform provided the other factors are uniform in value and the pressure at which the auxiliary reservoir and brake-cylinder equalize is supposed to be the same for all combinations of reservoirs and cylinders with the same initial pressure. To obtain this uniformity it is only necessary to properly proportion the reservoir volume to the brake-cylinder volume for some standard piston travel. We then have a pressure base which will be constant when the other factors involved have their proper or standard values. It would seem that this is the basis to which all braking power calculations should be referred for the reason that it is the nearest approach to a uniform and constant pressure obtainable under the wide range of conditions governing this choice. This adds to the standard enumerated in the preceding column the following:

3. This brake-cylinder pressure must be the equalized pressure on the auxiliary reservoir and brake cylinder.
4. A predetermined ratio between auxiliary reservoir volume and brake-cylinder volume to produce this equalization must be adhered to.

The fundamental steps in designing a brake system for any given car may now be outlined as follows:

Given the light weight of the car the proper braking power per cent has been established from results of experiment and experience and this enables the total brake shoe pressure to be calculated.

Mechanical considerations fix the total leverage ratio between certain limits, the maximum and minimum values of which enable a maximum and minimum total brake piston pressure to be calculated from the preceding.

This total brake piston pressure depends upon the size of cylinder and pressure per square inch used as a basis. The pressure basis to be used should be that agreed upon as a universal standard for such calculations as this and as has already been pointed out, uniformity requires that the *equalization pressure* (50 pounds per square inch) from the lowest standard brake pipe pressure carried should be the base chosen.

Having determined the unit pressure the size of cylinder can be chosen from the standard sizes manufactured to give the desired braking power with a total leverage within the maximum and minimum limits as defined above.

To obtain the desired 50 pounds equalization pressure from the standard 70 pounds brake-pipe pressure with a standard piston travel is simply a matter of correctly proportioning the auxiliary reservoir volume to that of the brake cylinder at the piston travel employed as standard.

We then have an auxiliary reservoir which, at 70 pounds initial pressure will equalize with its brake cylinder, when this has eight inches piston travel, at 50 pounds, and the brake-cylinder piston is of such an area that the total pressure thus obtained, when multiplied by the total leverage, will give a total braking

shoe pressure equal to the desired percentage of the light weight of the car

To be sure in an emergency application the braking power on all cars will be greater than that used in the design and the lighter the car the greater the variation between service and emergency braking powers But such non uniformity in actual service is bound to obtain and always has since an increase to 90 pounds brake-pipe pressure or a variation in piston travel produces similar results to say nothing of losses due to leakage resistances and variation in frictional coefficients The advantage gained however by the method of design outlined is therefore in the fixing of a uniform and actually obtainable brake-cylinder pressure which is necessary for service operations and is one of the most important factors in the calculation to be made

It may be said in passing that with the more recent types of brake equipments for passenger service using a supplementary reservoir volume in addition to that of a brake pipe to produce high emergency brake-cylinder pressure the size of supplementary reservoir used is calculated to give practically uniform brake cylinder pressures in emergency applications with *all* sizes of brake cylinders thus taking advantage of the principle of high pressures for emergency stops and at the same time conforming to the principles of uniformity laid down above it being a fundamental principle of modern brake design to keep the service equalization brake-cylinder pressure comparatively low for reasons fully explained elsewhere and use as high an emergency equalization pressure (as large a supplementary reservoir) as may be desirable

In the attempt to secure a high emergency brake cylinder pressure without the aid of the supplementary reservoirs referred to above the relationship between brake cylinder and auxiliary reservoir volumes existing in the *original* brake design was gradually lost the auxiliary reservoir volume being increased slightly from time to time as heavier cars requiring larger brake cylinders were equipped On the lighter equipment the variations thus introduced were relatively unimportant but in the case of heavy cars requiring the 16 inch and 18 inch cylinders it was impossible to increase the auxiliary reservoir volume sufficiently to obtain the desired emergency pressure without at the same time interfering to a marked degree with the proper operation of the equipment in service Consequently a compromise was made so as to obtain as high an emergency cylinder pressure as possible without increasing the service equalization pressure to an extent inconsistent with the proper normal functions of the brake

By the aid of a *supplementary reservoir volume* however reserved during service operation but available in emergency applications of the brake it is now possible to obtain the required increase in stopping power for emergencies and at the same time return to the original volume relationship the correctness of which has been established by long experience

These relationships are determined by the following principles which will be recognized at once as having been followed in even the earliest automatic brake designs

(A) For any given arrangement of leverage between the brake-cylinder piston and the brake shoes the braking power is directly proportionate to the gage pressure of air produced in the brake cylinder

(B) The limitation of the maximum allowable pressure of air in the brake pipe limits thereto the available pressure in the auxiliary reservoirs

(C) With this fixed maximum charge in the reservoir the highest pressure obtainable in the brake cylinder from this single source is that at which the air pressure equalizes between the two This (absolute) pressure therefore equals the product of the initial absolute pressure in and the volume of the auxiliary reservoir divided by the sum of the volumes of the auxiliary reservoir and of the brake cylinder (neglecting all clearance volume temperature effect etc) and the braking power is as the corresponding gage pressure

(D) This pressure of equalization should be limited because its height determines the range of those differences between final auxiliary reservoir pressure and initial brake-pipe pressure which range affords the control of "braking power applied

(E) That while low pressure of equalization limits "full service" pressure yet small range precludes nicety of control, especially as from the range there must be deducted such initial differences of pressure as are necessary to overcome the inertia and friction of the triple valve parts.

(F) That to afford heightened brake-cylinder pressure for use in emergency another quantity of air is necessary, and if this be, as in all past practice that contained in the brake pipe, the resulting absolute pressure will be equal theoretically to the maximum absolute brake-pipe pressure multiplied by the volume of the auxiliary reservoir plus the amount of air, in cubic inch pounds obtained from the brake pipe this sum then divided by the volume of the auxiliary reservoir plus that of the brake cylinder so that the measure of the resulting braking pressure is the gage pressure corresponding to this resulting (absolute) pressure

Now it is the interdependence and reactive results of these simple and recognized principles in their combinations together with a corresponding proportioning of leverage between the brake-cylinder piston and the brake shoes that determine the relative efficiency of a brake design

From (F) it is seen that if other parts be enlarged the volume of the brake pipe which is practically the same on all cars becomes relatively small and the emergency pressure sought is so insufficient that in the equipments for heavy rolling stock resort has been had to enlarged auxiliary reservoirs with a corresponding heightening of the full service pressure (C) and a resulting lessening of the range of control (D)

Again when (C) is heightened while (D) is lowered the results of the lighter brake pipe reductions cause magnified effects in the service braking so that when it is realized that such range as is possible is lessened by the lack of sensitiveness of the triple valve (F) there is likelihood of roughness of service stops

Such being the case it is apparent

1 That there is a ratio of volume of auxiliary reservoir to that of brake cylinder that should not be exceeded

2 That such service pressures as result in the brake cylinder should be made sufficient by a corresponding proportioning of the leverage

3 That the volume of each cars part of the brake pipe should be supplemented by proper means so as to afford the required braking pressure in emergency

Starting therefore with a brake cylinder of the size *dictated* by the vehicle to be equipped as already explained and by a proportioning of the leverage which shall accord with the service required and assuming that—

C equals volume of brake cylinder in cubic inches

P equals service equalization pressure in absolute units

R equals volume of auxiliary reservoir in cubic inches

a equals absolute initial pressure in the auxiliary reservoir

r equals permissible range of brake pipe reductions

it follows first from the above definitions that

$$r = a - P$$

and from (C) above neglecting clearance volumes

$$\frac{a \times R}{R + C} = P$$

from which

$$R = \frac{P}{a - P} \times C$$

$$= \frac{P}{r} \times C$$

which may be expressed in the following law

The proper auxiliary reservoir volume according to the principles laid down above is equal to the volume of the brake cylinder determined upon multiplied by the ratio of the service equalization pressure fixed upon as standard to the permissible range of brake pipe reductions

Assuming as in current practice that *P* equals 50 pounds per square inch (gage) and *a* equals 70 pounds per square inch (gage) then we have

$$r = a - P = 20 \text{ pounds}$$

and

$$R = \frac{P}{r} \times C$$

$$= \frac{65}{20} \times C$$

$$= 3\tfrac{1}{4} \times C$$

That is the volume of the auxiliary reservoir should be three and a quarter times the volume of the brake cylinder It is plain however that the effect of the clearance volumes leakages temperature and other adverse influence will be such that to obtain the desired results in actual service a somewhat higher auxiliary reservoir volume must be used than that found by the above calculations For example with the standard 8 inch equipment an auxiliary reservoir volume of 1 620 cubic inches is used which is about three and one-half times the brake-cylinder volume

In determining the proper size of supplementary reservoir (*F*) to be used, a similar reasoning may be used In addition to the symbols already defined let

S volume of supplementary reservoir in cubic inches

E absolute emergency equalization pressure

Assuming for the purposes of calculation that the emergency pressure is the result of the equalization of the brake cylinder auxiliary reservoir and supplementary reservoir volume it follows that

$$\frac{a\,(R + S)}{R + S + C} = E$$

whence by proper substitution and reduction is derived

$$S = \frac{a\,(E - P)}{r\,(a - E)} \times C$$

While the above expression is interesting as showing the simple relation which exists between the various volumes involved in the typical equipment as we have assumed it it must be clearly understood first that all the additional air supply in emergency is supposed to come from the supplementary reservoir having taken no account of that vented from the brake pipe and second that in any actual installation similar to that discussed the equalization is dependent upon the movement of certain valves actuated by spring and air pressures in combination the resultant effect of which is such that in the actual working equipment the state of affairs is by no means as simple as has been assumed for the typical equipment Instead of equalization taking place between all the volumes concerned simultaneously there are time limitations imposed on the rate of flow from the various sources of air supply to the brake cylinder so as to derive the maximum possible benefit from the compressed air stored in each There is also a material modification of these calculated results due to the processes not being truly isothermal as assumed and so on Proper allowance being made for these limitations a formula might be derived in the same manner as above to completely *cover the more complicated conditions but as only* the principles involved are now being considered it is unnecessary to go further into details particularly as these are accurately determined by experiment

In the above analysis as is necessarily the case with all theoretical considerations relative to mechanical apparatus of this character certain assumptions were made to furnish a basis from which to start Hence it should always be remembered that the formula derived must be interpreted for any given case in the light of the modification of these primary assumptions which the nature of the installation or the character of the apparatus used may involve With this understanding the above reasoning affords a logical and sound theoretical basis not only for determining the correct proportions of new types of equipment but also establishes a criterion by means of which the shortcomings of incorrectly designed installations may be discovered

BRAKES FOR ELECTRIC TRACTION SERVICE

It would hardly be proper to conclude without mentioning the fact that the electric traction service has required even more specialized apparatus than that already mentioned in connection with steam road service on account of the great variety of conditions under which electric cars operate from the single city street car up to the eight and ten-car subway and elevated trains to say nothing of the electric locomotive and multiple unit train service on electric division or steam railroads It can easily be appreciated that these phases of the subject are of even greater magnitude and require a greater variety of apparatus and complexity of detail than in the case of steam railroad service Consequently no more can be said at this time than to simply state the fact that the multiplicity of requirements has been anticipated and provided for to the extent that the high standard of efficiency already outlined has been maintained with out any compromise or failure to meet the requirements of the service In one particular at least the highest type of brakes for electric service namely the Electro Pneumatic System affords superior stopping power and service efficiency since its electric transmission of quick action insures simultaneously and almost instantaneously maximum braking power on all cars in the train while for service braking it possesses the maximum flexibility of control possible only in an electrically actuated brake system This brake therefore possesses superior features which are particularly noteworthy whether they are considered from the standpoint of the time saved the increased traffic made possible or the safety insured At the present time this type of equipment appears to be the acme of the braking art, but as past experience has always shown the same time which brings about changes in operating conditions is also sure to develop new and more efficient means for meeting new requirements

Saving Human Life in Mines

The Work of the United States Bureau of Mines

A LIFE-SAVING service for the rescue of miners in time of disaster is the first important step taken by the United States Bureau of Mines in its effort to reduce the appalling loss of life in American coal mines

Six specially constructed cars fully manned by a corps of miners trained in rescue work and equipped with the latest rescue apparatus and first aid to the injured appliances have been located in the midst of the great coal districts in different sections of the country These cars are ready at a moment's notice to proceed to the scene of a disaster where the rescue corps in co-operation with the state mining officials do everything possible to save entombed miners

During the year 1909 there were 2 412 miners killed in the coal mines and 7 979 injured In the coal and metal mines it is estimated that 3 000 men were killed and 10 000 were injured in 1909 For every 1 000 men employed from three to five men are killed each year in the mines of the United States In foreign countries from one to two are killed in each 1 000 employed In those European countries where the deaths are least per 1 000 men employed rescue apparatus has been in use for some time and it is with the hope that European conditions can be approached that rescue apparatus is being introduced here

The saving of human life is the emergency feature of a general campaign of educational work among the miners who are not only taught the use of rescue apparatus but also the proper way to care for an injured miner Lectures on different phases of the mining problem looking toward greater safety are given by the mining engineer attached to the car The mine rescue cars go to the miner in his own town or camp so there is little excuse for the miner not benefiting himself Each car has a specified territory and it is expected that every community of any importance will be visited In addition to a mining engineer, a surgeon of the American Red Cross accompanies each car The lectures delivered touch upon the use of explosives, electrical equipment, fire prevention sanitation and first aid to the injured surgical treatment When a suitable meeting place cannot be secured the lectures are given in the cars The itineraries are so planned that the cars remain long enough at each place for the miners to go through the training in rescue work which is in charge of the foreman of the car a practical miner

THE OXYGEN HELMET

NUMBER

The United States of America.

BUREAU OF MINES

DEPARTMENT OF THE INTERIOR

Certificate of Mine Rescue Training

This is to certify that ______ of ______

has been trained in the use of MINE RESCUE APPARATUS at the Government Mine Rescue Station at ______ during which training he performed hard labor within a gallery filled with noxious and irrespirable gases and gave evidence of being qualified to care for and use such apparatus within mines

Trained under the direction of *Approved*

Washington, D. C. ______ 191__

CERTIFICATE ISSUED BY THE UNITED STATES BUREAU OF MINES

The cars contain eight small oxygen helmets a supply of oxygen in tanks one dozen safety lamps one field telephone with 2 000 feet of wire resuscitating outfits and a small outfit for use in demonstration and actual practice of equipment relating to first aid to the injured in connection with mine accidents

One end of the cars is fitted up as an air tight room to be used in training men in the use of the small oxygen helmet This room is filled with noxious fumes and the miners wearing the helmets remain inside for two hours in an atmosphere that would kill without the helmets These are the helmets that permit one to enter a mine immediately following an explosion while it is still filled with poisonous gases, and breathe artificially

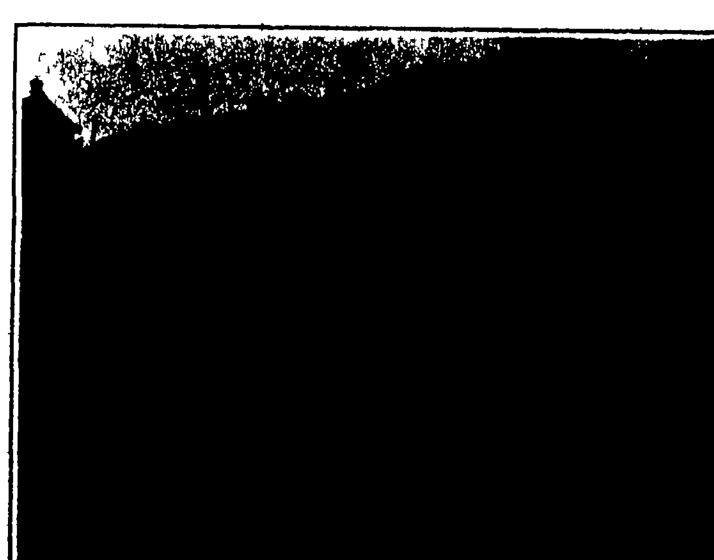
The absence of the helmets at great catastrophes in the United States has it is believed resulted in greater loss of life than necessary Frequently miners who have not suffered physical injury by an explosion have been entombed in the mine to die solely from the inhalation of the poisonous gases Had it been possible to reach these men within a few hours their lives might have been saved.

Every effort is made to encourage the miners to form rescue corps at the mines where they are employed and to have the operators equip them with the rescue apparatus As a result of the educational work along this line numerous coal operators throughout the country have purchased mine rescue equipment. For instance according to the annual report of the State Inspector of Coal Mines of Washington eleven companies have purchased thirty-one pieces of the Draeger rescue apparatus during the past year

The bureau has already trained more than five hundred men in rescue work and first aid to the injured It expects to train upward of three thousand men a year Each man taking the training receives a certificate The certificates are highly prized by the men and are usually framed and exhibited with great pride A large percentage of those who have taken the training have announced their intention of again taking it at the expiration of six months or a year They are all thoroughly trained in the use of the oxygen helmet and practically promise to be volunteers at any accident that occurs in their territory If the rescue car is near it will pick up these men on its way to the disaster Perhaps as a result of the rescue work of the bureau nearly one hundred coal companies have equipped themselves with complete rescue stations whereas in the past they not only had no trained rescuers, but had no apparatus to enter a mine

Past experience has been that in every big mine disaster a great many of the volunteer rescuers themselves have been killed At one mine disaster with seventy men killed fifty rescuers were among the number In the famous Cherry Mine disaster twelve men who went down as rescuers were brought up

THE IMPROVISED AMBULANCE CAR



A HOSPITAL CAR FOR MINE USE

SAVING HUMAN LIFE IN MINES

...ed on the cage. The death of rescuers has swelled the deaths of men killed in the mines. Since the Bureau of Mines has been established only two helmeted men or rescuers have been killed in mines.

There has never been any question as to the bravery of the miners in time of disaster. The only trouble has been the recklessness displayed. The miners have never hesitated to rush into danger in order to save a fellow worker and that is the reason so many have been killed. A very large percentage of the rescuers have met death owing to lack of proper equipment. For example, recently in a Pennsylvania mine some trouble was experienced and the superintendent and half a dozen of the best men went down to ascertain what the trouble was. They got in and were overcome but one of the number managed to telephone to the top. Several helmeted men went in and rescued them. If it had not been for the use of the helmet in this instance the men would have been killed. In a recent mine disaster in Ohio where a large number of fatalities resulted two men having been overcome lay along the floor of the working and had been passed by the rescuing parties for nearly twenty hours. One of the engineers of the bureau noticing them felt under the arm pits and found a slight warmth. The pulmotor was used and the men resuscitated. To-day these men are alive and working, whereas if it had not been for the application of the pulmotor they would have expired within a short time.

Eagle Hunting in China

A Lucrative Oriental Sport

Every year according to an old custom in the second quarter of the September or October moon the inhabitants of the Chinese province of Shantung go to Mongolia to hunt the eagles which abound in that region strewn with many bodies of animals and even of men. The huntsmen march in troops along the roads carrying on their shoulders long poles from which are suspended their baggage and provisions and on which are perched tame eagles to be used as decoys. Commandant Laribe encountering such a procession obtained the photographs which are here reproduced from *L'Illustration* from which we also take the details given below.

The hunters make use of a large net laid flat on the ground and baited with small dried fishes in the midst of which is placed the tame eagle. The decoy naturally begins to devour the bait and thus invites his wild cousins to follow his example. When the birds have alighted and are feeding the hunter from his hiding place two or three hundred yards distant quickly closes the net by means of a system of cords and thus captures the eagles.

Eagle hunting is very lucrative; the feathers are used in the manufacture of fans and are sold at a high price even in China.

There are three sorts: Kie-pei, black with white centers; Che-ma, white spotted with black; Tou-tsing, half white and half black. Several eagles are required to make a fan for only a small part of the plumage can be utilized. Hence these fans are very costly. A fan made of Kie-pei feathers may cost as much as fifty taels or about thirty dollars. A fan of Che-ma feathers is worth thirty taels. Fans made of the feathers which do not belong to any of the three sorts named are worth only a few taels. This information was obtained from a native of Kalgan on the Mongolian frontier. It is therefore probably correct.

Up-to-Date Pearl Diving

One by one industries of various kinds about which for centuries there has clung the atmosphere of romance are losing their glamor by reason of the advancement of practical science. For instance pearl diving. The era of naked divers exposed to peril from sharks has passed away; modern progress equips the pearler with a suit of India rubber, copper breastplate with leaden weights back and front, helmet, glass panelled and with telephonic attachments, air pipes, life lines and a submarine search light. Thus furnished forth the pearl diver may spend six or eight hours at the bottom of the sea, whereas in other times three minutes made a record.

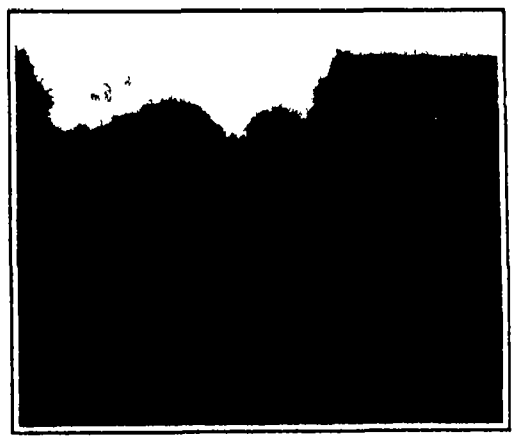
Although pearls are found in nearly all molluscs and even in univalves like the Australian haliotis, a kind of barnacle, true pearls are produced only by the pearl oyster or mother of pearl shell. The latter is really the diver's bread and butter. The shells are nearly as large as a dinner plate and weigh two pounds when cleaned. They fetch from $500 to $750 a ton.

The ancient fisheries were chiefly in the Indian Ocean and Persian Gulf but nowadays the best pearls come from Ceylon and from Australian waters, especially Torres Straits. Pearl fishing in Ceylon is a government monopoly. In March the fleet starts for the pearling grounds, each vessel with twenty or thirty divers and their assistants. But the headquarters of pearling are to be found in the desolate country extending from Exmouth Gulf to King Sound in Western Australia.

Chinese and Malays as well as tribes of native blacks are there to-day, but the old nude divers, the reign of terror and piracy where a large haul was made these and similar conditions have passed away, giving place to fleets of luggers carrying modern diving outfits and representatives of capitalists in the person of the master pearlers. Here is 600 miles of coast line, with perhaps 3,000 hardy adventurers engaged in the pearl trade.

There are some thousands of Japanese, Manilamen, Malays and men of other races acting chiefly as crews for the vessels. The vessels are schooner rigged and from seven to fourteen tons burden. Each carries a master diver and a crew of four, one of whom is the diver's assistant and works the air pumps.

The shells are found on ledges about ninety feet



TAME EAGLES USED AS DECOYS

down in the sea but they are far more plentiful at greater depths. Fortune awaits the inventor of a diving apparatus that will enable the pearler to work in comfort a hundred fathoms down.

A good day's work is anything more than 200 pairs of shells. The business is absolutely speculative. One diver may gather ton after ton of shells without securing anything of greater value than a few seed pearls while another may take a fortune out of a day's gathering.

The most famous pearl discovered in Australia of late years is known as the Southern Cross. It consists of a cluster of nine pearls in the shape of a cross. This freak of nature was picked up at low water on the Lacipede Island by a beach comber who after burying it for some time for superstitious reasons sold it for $50. It afterward brought $50 000.

The worst enemy the Australian pearl divers have are the storms that annually visit the coast. As to sharks, they rarely attack a diver in modern dress and he can always frighten them off by letting a few air bubbles out of his dress. Other enemies are the sea snakes, the smaller octopi, the stringray and the blowfish.

After a day's take of shell has been conveyed ashore the shell opener begins work at once. The pay of the men is $30 a month plus ten per cent on the value of the pearls found. Some idea of the magnitude of the industry may be obtained on learning that in one year five hundred and twenty luggers paid an annual five-dollar license to engage in the trade and that they took many thousands of tons of pearl shell, while as to the pearls themselves the customs duties in the pearl town of Broome exceeded $5 000 a month.

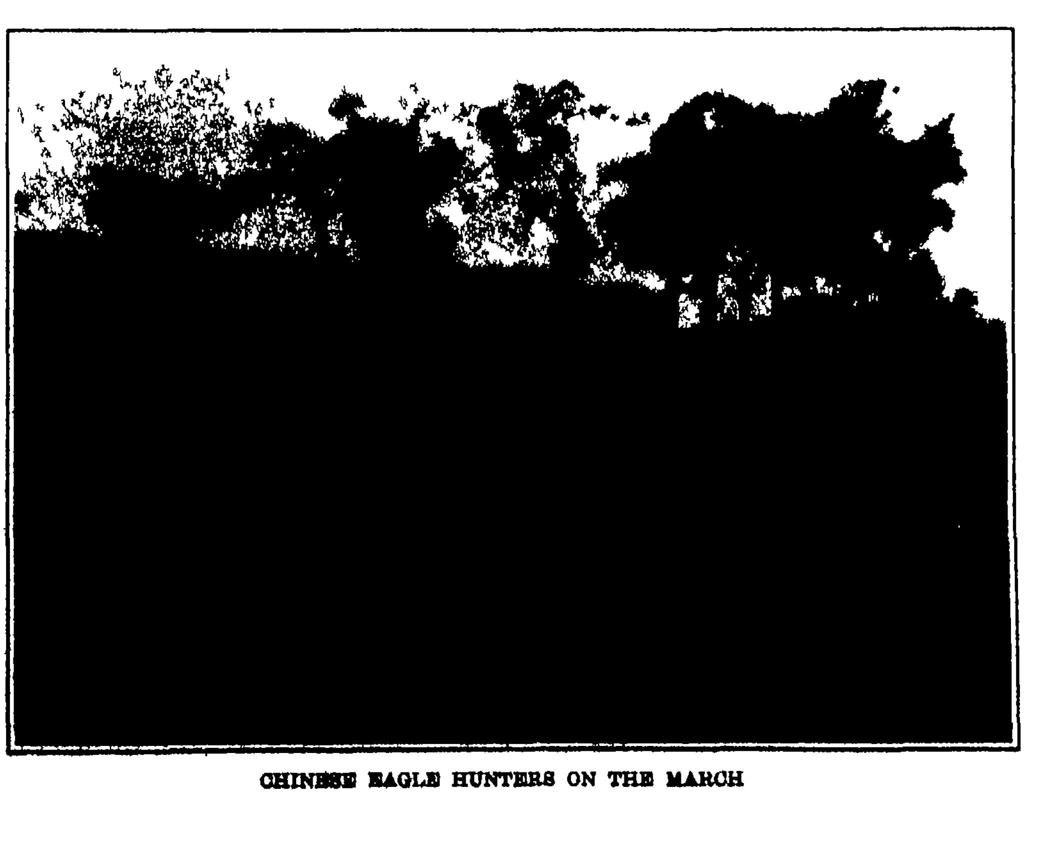
The treasury authorities of Western Australia estimate that they receive at least $100 000 a year in dues from the pearlers. Hardly a month passes without the discovery of pearls having a market value of from $5 000 to $15 000 each. A beautiful pink pear-shaped specimen weighing two hundred and six grains was found last season and sold for $80 000.

Before setting, pearls are classified according to size on a setting board and the delicate work of drilling a valuable specimen is invariably done by an old fashioned hand apparatus. Moreover no matter how valuable a set of pearls may be they are invariably strung on fine silk thread.

Inland pearl fishing forms no mean industry in this country. Although pearls have been gathered from the fresh water mussels of our country as far back as the time of the aborigines, yet the hunt for them did not become systematic and general until shortly after the middle of the last century. Since then nearly every stream east of the Rockies has been prospected in the search for these valuable parasites of the pearl mussel.

One of the finest pearls ever secured in the fresh waters of the United States was found in Notch Brook near Paterson, New Jersey, in 1857. It weighed ninety-three grains. Subsequently it became known as the Queen pearl and was sold for $2 500 to the Empress Eugenie. Owing to the great increase in the value of pearls in recent years it is now worth more than five times that amount.

Shortly after the year mentioned what was probably the largest pearl ever found in these waters was taken in the same brook. In shape it was round and weighed over four hundred grains, but unfortunately



CHINESE EAGLE HUNTERS ON THE MARCH

the pearl was ruined by the crude method of boiling them employed to open the shells

During the pearl excitement near Waynesville Ohio in 1876 a few extraordinarily good pearls were found One button shaped on the back weighing thirty eight grains was the gem of the collection In the early eighties a sky blue pearl which was found in Caney Fork Tennessee was sold for $950 and subsequently brought $3 300 in London

During the summer of 1889 a quantity of magnificently colored pearls were found in creeks and rivers of Wisconsin One of these pearls sold for over $ 00 and some among them were equal to any ever found for beauty and coloring

The year 1897 saw the pearling craze break out in Arkansas A deep pink pearl of forty grains weight was found in the mud of one stream by a woman while a farmer's boy obtained a pink pearl of thirty one grains in Black River and sold it for $35 the purchaser disposing of it in St. Louis a little later for $500

In 1898 a fisherman searched the head waters of the Mystic River in Connecticut and after a few week's work gathered a number of pearls one of which he sold for $500 and two for $400 each

The best price ever received by a finder for an American fresh water pearl was $10 000 for one from Tennessee Two others from the same State brought $650 and $1 000 each A Wisconsin pearl sold for $8 000 dollars while two Florida pearls of sixty-eight and fifty eight grain brought $850 and $600 respectively

A year or so ago there was offered for sale by a gem dealer of New York a perfect pearl white and rounded weighing sixty-eight grains which he valued at $15 000 This pearl was found near the Wisconsin bank of the Mississippi River, and was sold by the finder who evidently had not the slightest idea of its value, for seventy-five cents. Another pearl, found about the same time, was recently offered for sale in New York for $5 000 The latter is a pink pear-shaped pearl and weighs ninety nine grains

A few years ago a fisherman became so agitated on finding a pearl the size of a pigeon's egg in a mussel that he dropped it into the water and it was never recovered

Many odd-shaped pearls are found One was found in this country that strikingly resembled the bust of Michelangelo In a few instances small fishes crabs, and insects which entered the shell have been imprisoned and covered eventually with nacre thus making pearls of them at the same time retaining the animal's shape

Charles Darwin*

The Justification of the Darwinian Theory

By August Weismann

Forty-six years ago when I delivered my inaugural address as a professor of this university I took as my subject The Justification of the Darwinian Theory It is a great pleasure to me to be able to lecture again on the same subject on the hundredth anniversary of the birth of Darwin

This time however I need not speak of justifying the theory for in the interval it has conquered the whole world Yet there remains much that may be said much indeed that ought to be said at the present time In my former lecture I compared the theory of descent or evolution to the Copernican Cosmogony in its importance for the progress of human knowledge and there were many who thought the comparison extravagant But it needs no apology now that the idea of evolution has been thoroughly elaborated and has become the basis of the science of life

You know that Darwin was not the only one and was not even the first to whom the idea of evolution occurred It had arisen in several great minds half a century earlier and it may therefore be thought an injustice to give as we now do almost all the credit of this fruitful discovery to Darwin alone

But history is a severe and inexorable judge She awards the palm not to him in whose mind an idea first arises but to him who so establishes it that it takes a permanent place in scientific thought for it is only then that it becomes fruitful of and an instrument for human progress The credit for thus establishing the theory of evolution is shared with Charles Darwin only by his contemporary Alfred Russel Wallace of whom we shall have to speak later

Nevertheless a reflection of the discoverer's glory falls upon those who about the end of the eighteenth and the beginning of the nineteenth century were able to attain to the conception of evolution notwithstanding the incomparably smaller number of facts known to them As one of these pioneers we must not omit to mention our own poet Goethe though he rather threw out premonitory hints of a theory of evolution than actually taught it Alle Gestalten sind ähnlich doch keine gleichet der andere und so deutet der Chor auf ein geheimes Gesetz

The secret law was the law of descent and the first to define this idea and to formulate it clearly as a theory was as is well known also a Darwin Charles Darwin's grandfather Erasmus, who set it forth in his book Zoonomia in 1796 A few years later Treviranus a botanist of Bremen published a book of similar purport and he was followed in 1809 by the Frenchman Lamarck and the German Lorenz Oken

All these disputed the venerable Mosaic mythus of creation which had till then been accepted as a scientific document and all of them sought to show that the constancy of species throughout the ages was only an appearance due as Lamarck in particular pointed out to the shortness of human life

But Cuvier the greatest zoologist of that time a pupil of the Stuttgart Karlsschule would have none of his idea and held fast to the conception of species created once for all seeing in it the only possible explanation of the enormous diversity of animal and plant forms

And there was much to be said for this attitude at that time when the knowledge of facts was not nearly comprehensive enough to afford a secure and scientific basis for the theory of descent Lamarck alone had attempted to indicate the forces from which in his opinion, the transmutation of species could have resulted

It was not however solely because the basis of fact was insufficient that the theory of the evolution of organic nature did not gain ground at that time it was even more because such foundation as there was for it was not adhered to All sorts of vague speculations were indulged in and these contributed less and less to the support of the theory the more far reaching they became Many champions of the Naturphilosophie of the time especially Oken and Schelling promulgated mere hypotheses as truths forsaking the realm of fact almost entirely they attempted to construct the whole world with a free hand so to speak and lost themselves more and more in worthless phantasy

This naturally brought the theory of evolution and with it Naturphilosophie into disrepute especially with the true naturalists those who patiently observe and collect new facts The theory lost all credence and sank so low in the general estimation that it came to be regarded as hardly fitting for a naturalist to occupy himself with philosophical conceptions

This was the state of matters onward from 1830 the year in which the final battle between the theory of evolution and the old theory of creation was fought out by Geoffroy St Hilaire and Cuvier in the Paris Academy Cuvier triumphed and thus it came about that an idea so important as that of evolution sank into oblivion again after its emergence and was expunged from the pages of science so completely that it seemed as if it were for ever buried beyond hope of resurrection

Scientific men now turned with eagerness toward special problems in all the domains of life and the following period may well be characterized as that of purely detailed investigation

Great progress was made during this period entirely new branches of science were founded and a wealth of unexpected facts was discovered The development of individual organisms of which little had previously been known began to be reavealed in all its marvelous diversity first, the development of the chick in the egg then of the frog then of insects and worms then of spiders crustaceans starfishes and all the classes and orders of mollusks as well as of backboned animals from the lowest fish up to man himself Within this period of purely detailed investigation there falls also the discovery in animals and plants of that smallest microscopically visible building stone of the living body the cell and this discovery paved the way for the full development of the newly founded science of tissues histology

In botany the chief progress in this period was in regard to the reproduction and development of the lower plants or cryptogams and the discovery of alternation of generations a mode of reproduction that had previously been known in several groups of the animal kingdom in polyps and medusæ in various worms and later in insects and crustaceans

At the same time it was found that the proposition which had hitherto been accepted as a matter of course that an egg can only develop after it has been fertilized is not universally valid, for there is a development without previous fertilization—parthenogenesis or virgin birth

Thus in the period between the Napoleonic wars and 1859 an ever increasing mass of new facts was accumulated and among these there were so many of an unexpected nature that further effort was constantly being put forth to elucidate detailed processes in every domain This was desirable and imporant—was indeed, indispensable to a deeper knowledge of organic nature. But in the endeavor to investigate details naturalists forgot to inquire into the deeper causes and correlations, which might have enabled them to build up out of the wealth of details a more general conception of life So great was the reaction from the unfortunate speculations of the so-called Naturphilosophie, that there was a tendency to shrink even from taking a comprehensive survey of isolated facts which might lead to the induction of general principles.

How deep was the oblivion into which the philosophical conceptions of the beginning of the century had sunk by the middle of it may be gathered from the fact that in my own student days in the fifties I never heard a theory of descent referred to and I found no mention of it in any book to which I had access One of the most famous of my teachers the gifted anatomist J Henle had written as a motto under his picture There is a virtue of renunciation not in the domain of morality alone but in that of intellect as well This sentence was entirely obscure to me as a student, because I knew nothing of the intellectual excesses of the Naturphilosophie and I only understood later after the revival of interest in general problems that this insistence upon the virtue of intellectual renunciation was intended as a counter active to the over speculations of that period

This was one-sided but it was a necessary reaction from the one-sidedness in the opposite direction which had preceded it

The next swing of the pendulum was brought about by Charles Darwin in 1859 with his book on "The Origin of Species

Let us now consider the development of this remarkable man and note the steps by which he attained to his life work Charles Darwin was born on the 12th of February 1809 the same year in which Lamarck published his Philosophie Zoologique" But he had not sucked in the doctrines of that evolutionist or of his own grandfather Erasmus Darwin with his mother's milk His youth fell within the period of the reaction from philosophical speculation, and he grew up wholly in the old ideas of the creation of species and their immutability His birthplace was the little town of Shrewsbury near the borders of Wales where his father was a highly respected physician well to do even according to English standards

If we think of Charles Darwin's later achievements we are apt to suppose that the bent toward natural science must have been apparent in him at a very early age but this was not the case at least not to a degree sufficient to attract the attention of those about him It is easy now of course, to say that the pronounced liking for ranging about wood and field and collecting quite unscientifically plants, beetles, and minerals, foreshadowed the future naturalist Even as a boy Darwin was an enthusiastic sportsman and an excellent shot, and the first snipe he brought down excited him so much that he was hardly able to reload[1] But he must have been not merely a sportsman but an eager observer especially of birds, for at that time he wondered "in his simplicity" that every gentleman was not an ornithologist, so much was he attracted by what he observed of the habits of birds.

The school which he began to attend at Shrewsbury in his ninth year was probably very similar to our earlier gymnasia. Darwin himself maintained that nothing could have been worse for his intellectual development than this purely classical school, in which

* An address delivered at the University of Freiburg on the occasion of the Centenary of Darwin Reprinted from *The Contemporary Review*

[1] I can say the same of myself for, although in my boyhood I did not shoot birds, I had a passion for butterfly hunting. When I saw the rare *Limenitis populi* resting on the ground in front of me for the first time, I became so excited that I could not at first throw my net, and when I did throw it, though my aim was usually very accurate, I struck the butterfly obliquely over the wing with the iron ring of the net. The traces of this awkward aim are visible on the wing to this day.

nothing was taught, in addition to the ancient languages, except a little ancient history and geography

Darwin had no talent for languages and no pleasure in them So he remained a very mediocre scholar and his father therefore removed him from school in his sixteenth year, and sent him to the University of Edinburgh to study medicine

The condition of the English universities at that time must have left much to be desired for Darwin characterises the majority of the lectures as terribly dull, and the time spent in attending them as lost Moreover, anatomy disgusted him and the tedium of the geological lectures repelled him so that he vowed never again to open a book on geology a resolution which happily he did not adhere to

In his student days as in his school time he roamed about in the open air sometimes shooting sometimes riding sometimes making long expeditions afoot But even then he was not a conscious observer of nature not a naturalist but rather a lover of the beauty of nature and a collector of all sorts of natural objects though he collected still as he had done at school rather from the collecting impulse frequently characteristic of youth than from any real scientific interest If he had had that interest his chief passion would not have been the shooting of birds. His friends even found him one day making a knot in a string attached to his buttonhole for every bird he succeeded in bringing down! Thus he must have been mainly a sportsman a hunting fanatic whose chief desire was to bring down as many birds as possible in a day However this devotion to sport must have stood him in good stead later especially on his great journey for through it he not only acquired the technique of shooting but he sharpened his naturally acute powers of observation

He remained two years in Edinburgh and then entered the University of Cambridge His father who had observed his disinclination for medicine proposed that he should study theology and Darwin knew himself so little that he was quite willing to agree to the proposal He examined himself very conscientiously to see whether he was able to subscribe to the dogmas of the Anglican Church and he came to the conclusion that he could accept as truth every word that the Bible contained This was certainly remarkable and proves that the Zoonomia of his grandfather Erasmus and the doctrines of Lamarck as far as he was acquainted with them had not taken very deep root

So he proceeded to study theology But he did it much in the same way as he had studied medicine in Edinburgh he listened only to what pleased him and that can not have been very much for here too he complained of the dullness of official lectures Nevertheless at the end of three years he passed his examination quite creditably and received the degree of B A

Of the greatest advantage to him in Cambridge was his intercourse with two distinguished teachers of the university and this intercourse probably guided him imperceptibly toward the real work of his life One of these teachers was Prof Henslow a theologian who afterwards accepted a living but who had a comprehensive knowledge not only of entomology but of chemistry botany mineralogy and geology By Henslow Darwin was introduced to the professor of geology Sedgwick and he too interested himself greatly in the young man taking him with him on his longer geological excursions and thus giving him a most valuable introduction to the science This proved of the greatest use to Darwin on his travels and probably enabled him to make his numerous geological observations

Other older men also admitted Darwin to their friendship so that it is obvious that there must have been something about him even then which distinguished him from others of his age His interests now began to widen, he came under the educative influence of art and studied the picture gallery in Cambridge and later the National Gallery in London He gained the entrance to a musical circle and derived great pleasure from music though curiously enough as he tells us he was almost destitute of ear and could not even whistle God Save the King correctly He was thus one of those rare persons who are exceedingly sensitive to the emotional effect of music and yet possess little or nothing of its physical basis the sense of tone

In addition to all this Darwin retained his passion for beetles and collected with such ardor that twenty years later he recognized at sight small rare species he had found under bark or moss at that time His powers of observation had thus been awakened although as yet they were employed mainly to minister to his zeal for collecting But collecting is not a mere amusement for the young naturalist it is a necessary discipline in surveying a definite range of forms and it can not well be replaced by anything else One who has never collected and thus never made himself thoroughly acquainted with a limited circle of forms will find it difficult to fill up the gap in his attainments in later life

In vacation time toward the autumn of each year Darwin turned again with enthusiasm to sport either at his home in Shrewsbury or on his uncle Wedgewood's large estate of Maer He did not lose a possible day from this amusement for as he says in his autobiography I should have thought myself mad to give up the first days of partridge shooting for geology or any other science Thus notwithstanding his interest in geology and beetle collecting in pictures and music the old passion for the chase was still the dominant one one pleasure crowded upon another and the whole made his life a joyous symphony so that he could say of that period The three years which I spent at Cambridge were the most joyful in my happy life But in the midst of all the joyousness of life he was undergoing an inward preparation for the seriousness of it We can gather from his own account of that time that the strongest impulse toward the study of natural science came from reading two works which aroused his interest, Humboldt's Personal Narrative and Herschel's Introduction to the Study of Natural Philosophy Darwin says of these No other book influenced me so much as these two He used to copy long passages from Humboldt about Teneriffe and read them aloud to Henslow He was very anxious to go to Teneriffe and even made inquiries in London about a ship to take him there when an event happened which overthrew that project but at the same time opened up the way to a naturalist's career—the only one really suited to him—in a much more satisfactory manner He received a proposal to make a voyage round the world

It must appear to us singular that a young man who had just finished his university course and had done no scientific work of any kind should be invited to accompany as a naturalist a naval vessel which was being sent round the world by the government for the purpose of making nautical observations It proves that Darwin's older friends must have had very high expectations in regard to his future

Capt Fitzroy of the English navy was looking for a young man who would go with him as naturalist on a voluntary footing on his voyage in the Beagle

Darwin himself was at once eager to accept but his father objected very decidedly seeing no reasonable object in spending five years ranging over the globe But he concluded his letter with the sentence If you can find any man of common sense who advises you to go I will give my consent

The necessary adviser was found in his uncle Wedgewood who as soon as he heard of the matter immediately drove the 40 miles from Maer to Shrewsbury and persuaded the elder Darwin that he must allow his son to go

Thus it happened that Darwin made the journey which he speaks of later as the most important event of my life as it undoubtedly was It was only later that he learned that even then his going was not a certainty for Capt Fitzroy after seeing him was in doubt as to whether he should accept him for a reason not easy to guess because of the shape of his nose! Fitzroy was an enthusiastic disciple of Lavater whose doctrine of physiognomy was then widespread He believed that the shape of Darwin's nose proclaimed a lack of energy and he was doubtful about taking anyone deficient in that quality on such a journey Happily Darwin's friends were able to reassure Fitzroy on this point and he must often enough afterward have had opportunity to convince himself of Darwin's energy

Thus it was apparently by mere chance that Darwin got the opportunity to develop actually into the great naturalist we now know that he must have been potentially But I do not believe that this is a correct judgment His inward impulse would certainly have forced a way after he had been led to perceive through Humboldt and Herschel what the way for him was to be And even at that time no serious obstacle would be likely to stand in the path of a young Englishman of fortune who wished to explore foreign lands and seas But undoubtedly this manner of traveling for five years through the seas and countries of the different zones was particularly advantageous

And Darwin used his opportunities to the full On board ship he studied the best books especially Lyell's Principles of Geology but he also collected certain kinds of natural objects and investigated all that came in his way keeping a detailed journal of everything that struck him as worthy of note in what he observed Thus he became a well informed and many sided naturalist But he valued much more highly than any other result of the voyage the habits of energetic industry and concentrated attention to whatever he had in hand that he then acquired And thus he became the great naturalist for which nature had designed him

Darwin published his journal later it fills a closely printed volume of 500 pages Like all his books it is characterized by a simplicity and straightforwardness of expression there is absolutely no striving after sensational effect but an innate enthusiasm and truth pervades it and I have always found it most enjoyable reading Other people must have found it so too for by 1884 16 000 copies of the English edition had been sold I cannot here give even a brief account of the voyage of the Beagle I can only say that its work lay chiefly on the southern coast line of America and the journey included the east coast of Bahia to Tierra del Fuego and the inhospitable Falkland Islands and the western coast to Ecuador and Peru

This occupied several years and thus the young explorer had a chance to make himself thoroughly acquainted with a great part of the South American continent for while the ship lay at anchor taking soundings in some bay or other Darwin ranged over the country on horseback in a boat or on foot In Brazil on the plains of the La Plata River and in Patagonia he made excursions into the interior which lasted for weeks and he was thus able to see and investigate everything that interested him

(To be continued)

Bienaimé's Proposed Ascension

M MAURICE BIENAIMÉ is to make an interesting balloon ascension from Paris especially for meteorological and other scientific observations Without wishing to break the record which was made by the German aeronauts Suring and Berson in 1901 at 10,800 meters (35,433 feet) altitude, he expects with a much smaller balloon of 1,600 cubic meters (56 502 cubic feet) of the usual touring size, to go higher than the 8,558 meters altitude (28 077 feet) reached by Balsan and Godard in 1900 Seeing that the aeroplane has not been used as yet for exploring the upper atmosphere to any extent, this must be done by sounding balloons of small size or by regular balloons mounted by an aeronaut Such observations are more difficult to make than may be thought, seeing that the air pressure becomes much less and is only one-half of the ordinary when we rise to 15 000 feet This causes bleeding from the nose and ears and like disorders, while the rarefied air becomes difficult and even impossible to breathe. Intense cold is another point and it may reach 40 deg below zero C added to which is the altitude sickness so that the aeronaut is likely to become paralyzed or in a lethargic state and this may even cause death However by using the proper precautions M Bienaimé expects to make his ascension a success The scientific commission of the French Aeronautic Club has laid out a programme for this occasion The radio-activity of the atmosphere and the solar heat are to be observed

As the air is always more or less a conductor of electricity and its conductivity varies with the altitude it is of interest to measure this at different heights The value depends on the number of electrified particles or ions in a given amount of air Experiments made on mountains are not of much value as the electric charge follows the reliefs of the ground From a practical standpoint the study of the distribution of these particles in the atmosphere is important in meteorology, seeing that it is now admitted that this is the cause of rainfall Besides electric charges in the upper air allow of explaining the variations of terrestrial magnetism Such variations are often very considerable and cause disturbances which may interfere with telegraphs or telephones as is well known It is found that magnetic disturbances always coincide with the appearance of the aurora borealis Apparatus will be carried on board for making observations in this field For other work there will be used various kinds of instruments such as a sphymograph for registering arterial tension and a Mathieu instrument for measuring muscular force at different altitudes Registering instruments of the Richard type will serve to make records of the temperature of the air and the moisture Other recording devices will take the highest altitude which is reached and make other measurements M Albert Senouque will have this work in charge and he is well known for his researches in terrestrial magnetism during the Charcot expedition to the Antarctic regions having also made researches at the Mont Blanc observatory.

Reclamation of the Southern Louisiana Wet Prairie Lands—I*

By A D Morehouse, Office Engineer, Drainage Investigations*

INTRODUCTION

In the conquest of the country the heavily timbered areas of the East have been subdued the vast prairie lands of the Middle West have been settled the riches of the west coast have yielded of their stores the waterless regions of the Great American Desert have been turned into verdure under the magic of irrigation and dry farming has brought into productiveness turies by that river and its tributaries and deposited here by every recurring flood they form now the most fertile agricultural lands of the State equaled by few and surpassed by none in the world in productive capacity as described by Dr Hilgard in writing of this region

FORMATION OF THE LANDS

Recent borings to a depth of 3 170 feet in the was deposited in the more slowly moving waters away from the main currents of the streams This point, as well as the fact that the natural drainage is away from the river is well brought out by the following from A Preliminary Report Upon the Bluff and Mississippi Alluvial Lands of Louisiana by W W Clendenin[1] written a few years since

'With every flood the river now overflows its flood

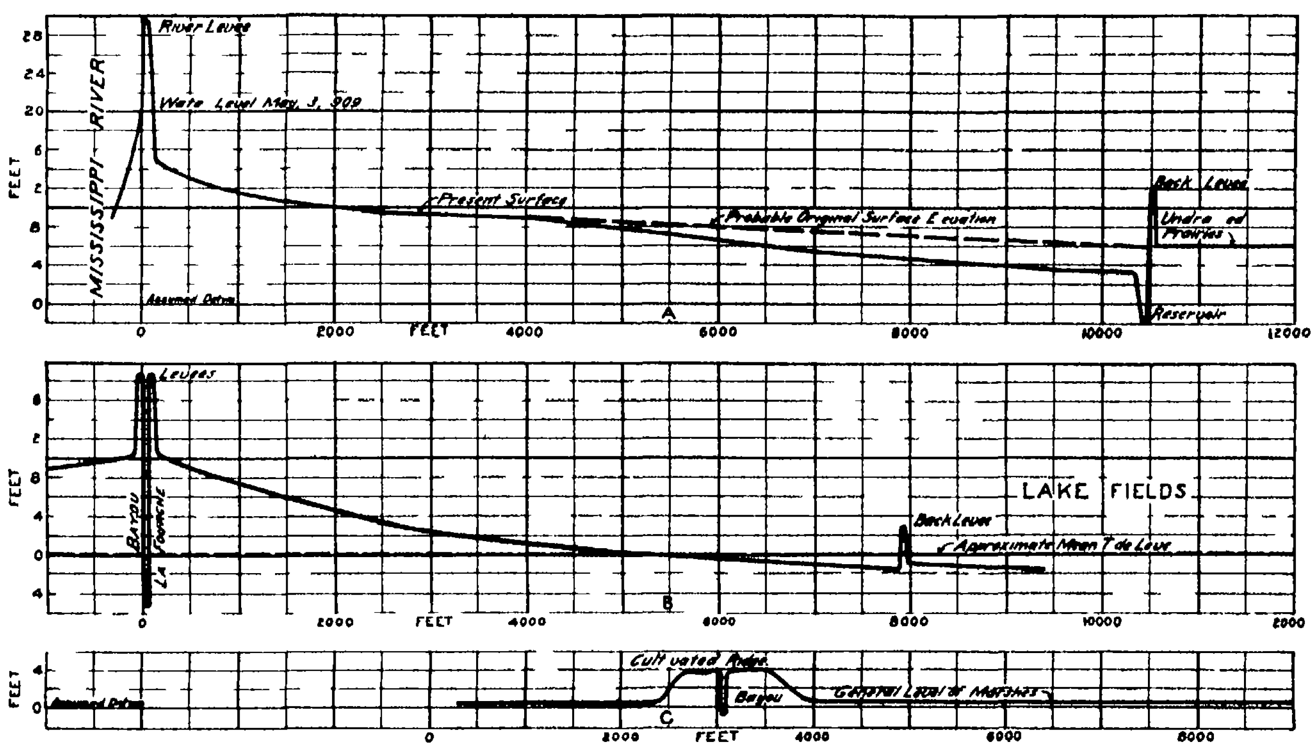


Fig 1 TYPICAL EXAMPLES OF LOUISIANA MARSH LAND FORMATION

A profile through Willswood plantation B section through Smithport plantation C formation caused by small bayou near Lockport

immense sections of land once considered worthless However throughout the space of the several centuries which have witnessed this wonderful development one of the richest sections of the country's great domain has lain unused and unproductive first clothed in the mystery cast upon it by its Spanish ownership and later since its acquisition by the United States associated in the minds of men with visions of pestilential swamps deemed worthy only of neglect owing to the supposed difficulties of its reclamation and never thought to be a region whose wonderful agricultural possibilities would test the credulity of men

Within the last few years all this has changed and the alluvial prairie lands of southern Louisiana are coming into their own Formed by the richest soils of the whole Mississippi Valley brought down for cen

vicinity of Houma have failed to penetrate this layer of sediment and at a depth of 2 400 feet pieces of fairly preserved wood have been encountered Owing to the fact that the soil is water laid material nothing coarser than river sand is encountered except the overlying layer of humus formed by the decaying vegetation A typical section of these lands would show a layer of humus or muck 2 or 3 feet thick overlying a grayish or drab clay subsoil composed of very fine particles which when saturated form a tough impervious mass Layers of sand of varying thickness are encountered in this clay subsoil and occasionally no clay stratum intervenes between the humus and sand The surface soil is from a few inches to 5 feet or more in thickness

NATURAL LEVEES

The embankments or natural levees along all the bayous and streams with which this region abounds and those along the Mississippi are formed by the constant overflows They are composed of coarser sand than the clay subsoil of the prairies as this latter

plain and deposits much of the sediment from its headwaters As with a slight increase in velocity the transporting power is vastly increased so with a slight checking of velocity as occurs over the flood plain outside of the channel deposit takes place As the greatest decrease in velocity takes place near the channel there the heaviest and coarsest sediment is deposited and in greatest quantity The river banks are thus built higher by each flood and a system of natural levees is produced There is thus a marked difference in the front lands and the back lands along the river The former are higher and coarser textured than the latter and therefore much more easily cultivated and drained

Drainage from the very channel margin is away from the river and unless forced by the topography of the land will not reach the river proper but unite with some outlet of the river produced during some extraordinary flood period and kept open by the escape of water during ordinary periodic flood stages As the feeders of the river are called tributaries these

* This article is based on reports to the chief of drainage investigations by A M Shaw C E New Orleans, La, and of W B Gregory M E Tulane University of their investigations made during 1909 and also upon data furnished by C W Okey assistant drainage engineer who continued the work of this Office during 1910 in Southern Louisiana All quotations not otherwise credited are from the foregoing mentioned reports the portions referring to pumping equipment being by Professor Gregory and the rest by Mr Shaw

For a discussion of these soils see U S Dept Agr Field Operations of the Bureau of Soils 1903 p 430

[1] Louisiana Stat Rpt Geology and Agriculture Pt IV p 968

Fig 2 —WILLSWOOD PLANTATION ST CHARLES PARISH LA SHOWING PUMPING PLANT AND MAIN RESERVOIR, WITH LEVEE ON RIGHT BANK

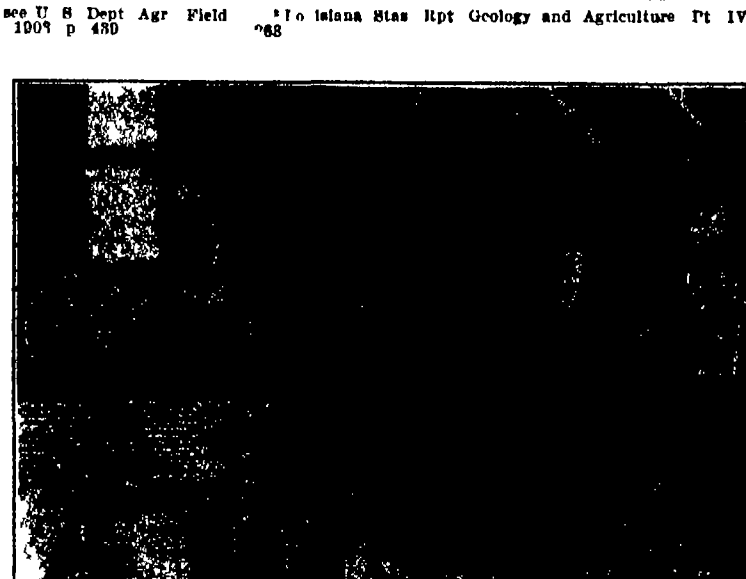


Fig 3 —INTERIOR VIEW OF PUMPING PLANT, WILLSWOOD PLANTATION, ST CHARLES PARISH, LA., SHOWING ARRANGEMENT OF MACHINERY

outlets have not inaptly been styled distributaries

The water in breaking over the banks and spreading over the marshes in sheets was gradually lessened in velocity thus gradually dropping its load of sand and silt and causing a delicate gradation of soil texture to the finest river silt far out in the marshes These natural levees and those that have been constructed and the improved methods of closing crevasses in the levees have reduced the danger from general overflows to a minimum, and whereas this has prevented much damage which would be caused by the cutting out of new channels and the destruction of much valuable property it has also checked the building up of the lowlands and their natural conversion from marshes to well-drained fields Thus it is that nature has forced upon man the necessity of exercising his ingenuity and labor in wresting these productive lands from their water ridden state even as centuries ago the brave and industrious Hollanders wrested their empire from the sea

Many of the streams and bayous now isolated have served in times past as mouths of the Mississippi or as overflow outlets in times of flood and they have been instrumental in the distribution of the rich silt laden waters and in the gradual advance of the coast line

"Even before the construction of the artificial levee system there was no raising of the general level of the marshes during periods of normal flow and probably little sedimentation of the river bed excepting at its mouth the most of the material which was carried in suspension to the lower portion of the river being carried out and deposited in the Gulf As the river rose however the waters constantly sought additional outlets through the various bayous of the delta country At times of extreme high water there was a general breaking over the banks of the river and its outlets It is probable that the most of the building up of the lands above sea level has been done at such times

The fact of the silt bearing capacity of water being directly dependent upon the velocity is clearly demonstrated by observing the natural embankments formed by streams of various sizes In the case of smaller streams when the water overflows its force is soon spent and the silt is quickly deposited near the stream forming narrow ridges with steep side slopes while those formed by large streams are broad with slight slopes Three typical examples showing this difference and the manner in which the land surface has been raised on the marshes are given in Fig 1 A B and C

The sections were taken as follows

A—From the right bank of the Mississippi River across the Willswood plantation about ten miles above New Orleans This section is about two miles long and a part of the lands crossed has been under cultivation for a great many years while those farthest from the river were reclaimed only twelve or fifteen years ago

The lowering of the surface of the cultivated and drained fields due to the shrinkage of humus soils is here well illustrated There are many examples of highlands having been built up for much greater distances from the river than this but as such accretions are indirect on account of being formed by a number of small bayous or temporarily contracted areas of overflow which assisted in maintaining the velocity these have not been considered as being typical

B—The right bank of Bayou La Fourche at Lockport extending back through the village of Lockport and the lands of the Smithport Planting Company to Lake Fields. Until 1903 Bayou La Fourche served as an overflow outlet for the Mississippi River the opening at Donaldsonville not having been permanently closed until that year

C—This is a very small bayou running through the lands of Dr I D Fay about four miles west of Lockport The abrupt rise of the ridge from the surrounding marshes is especially noticeable and is characteristic of smaller bayous

Important exceptions to the foregoing general statement as to the relation between the size of bayous and the ridges built by them are frequently found

From the foregoing discussion it is seen that these lands may not in general be drained through gravity outlets in the ordinary way but that it is necessary to surround them by levees or embankments and then by the construction of an interior drainage system

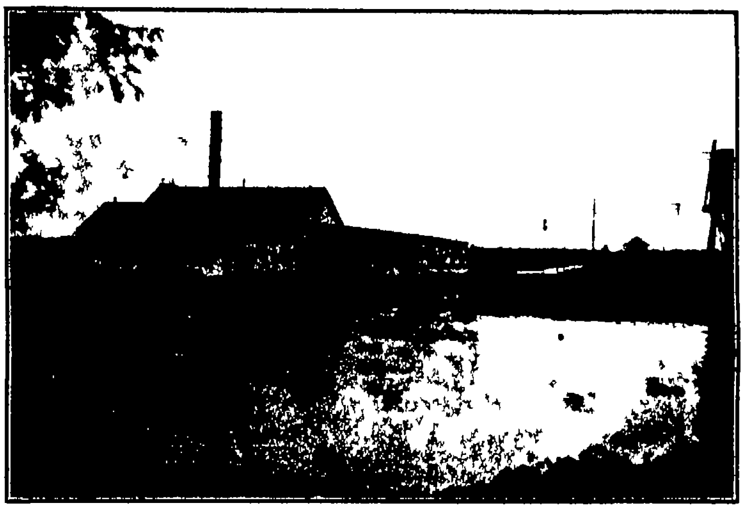


FIG 6—MODERN PUMPING PLANT AT LA BRANCH ST CHARLES PARISH LA SHOWING OUTLET CANAL AND DISCHARGE FROM PUMPS

Prominent among those are the Bayou l'Ourse in the southeastern part of La Fourche Parish and the Wax and Little Wax Bayous in St Mary Parish Bayou l'Ourse is an insignificant stream occupying the center of a long and important ridge It is probable that at one time this bayou served as an outlet for the La Fourche or possibly of some predecessor of the latter bayou draining in a more easterly direction through Bayou Blue Lake Fields and Long Lake Wax and Little Wax Bayous are streams of

FIG 7—OUTLET CANAL ON A LARGE SUGAR PLANTATION IN SOUTHERN LOUISIANA SHOWING IT COMPLETELY FILLED WITH WATER HYACINTHS

erosion rather than of sedimentation and have been formed wholly or in part by the action of storms and the tidal flow which is quite strong along this portion of the coast. As a result the bayous are bordered by the marsh or by very low ridges Both streams are from ten to fifty feet in depth and 100 to 200 feet in width

of ditches lead the drainage water to some convenient point from which it is pumped over the embankment into the adjacent stream or bayou

PURPOSE OF INVESTIGATIONS

The development of these lands is now progressing with such rapidity that the United States Department of Agriculture through drainage investigations of the Office of Experiment Stations decided in the spring of 1909 to make a study of the conditions entering into the reclamation of these most valuable lands

The engineers making the investigation were charged to determine the volume of water or percentage of the rainfall which it is necessary to pump from the fields in order to secure adequate drainage of these soils the area of the field surface served by ditches and the depth width and arrangement of the ditches and the levees required in a drainage system the influence of bad physical condition of ditches upon the efficiency of the system the distance from the ground surface at which the water table should be maintained the difference in the level of the water in the ditches while the pumps were in operation the percentage of saturation or the quantity of water which the soil should contain when in the best condition for growing crops

Accordingly four reclaimed tracts of land were chosen in the vicinity of New Orleans which were regarded as having good ditch systems coupled with ample pumping capacities and as practically no information was extant as to the relation of rainfall to the resulting run off from these lands rain gages were established on each tract and continous rainfall records kept in order to compare them with the pumping records for the same period

The following gives a brief description of the tracts in question including their pumping machinery equipment and also describes a new tract District No 3 which is being reclaimed

DESCRIPTION OF EXPERIMENTAL TRACTS

Willswood Plantation 2400 Acres

The plantation fronts on the Mississippi about ten miles above New Orleans and is crossed by the Southern Pacific Railway The tract was enlarged twelve years ago necessitating the digging of new canals and the replacing of the old wheel pump by an up to date pumping plant Sugar cane is grown principally but some corn and cowpeas are also raised

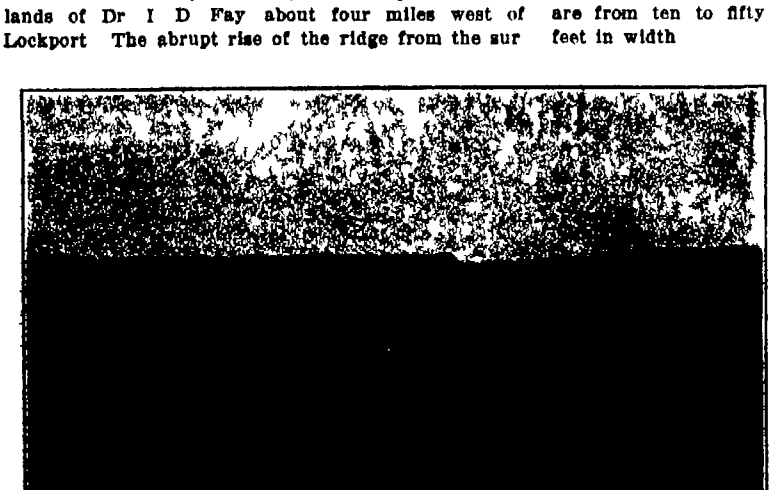


FIG. 4.—TYPICAL WET PRAIRIE SCENE, SHOWING WILD GRASSES. DISTRICT NO 2, NEAR RACELAND, LA FOURCHE PARISH, LA.

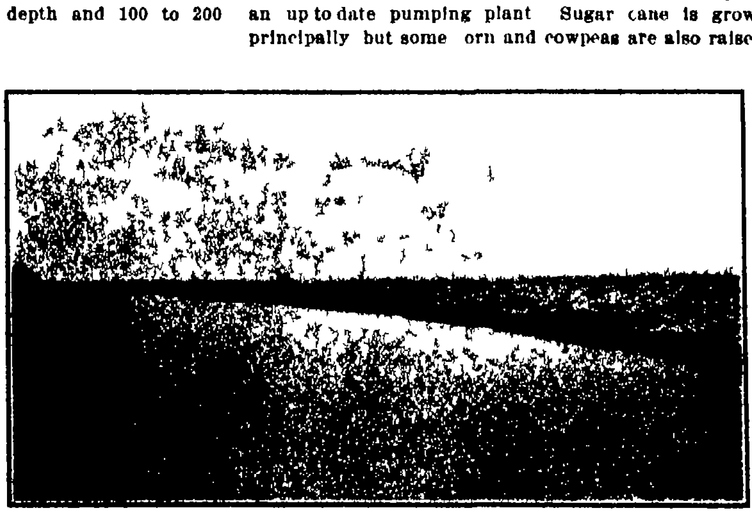


FIG 5—DISTRICT NO. 2, NEAR RACELAND, LA FOURCHE PARISH LA AFTER RECLAMATION, SHOWING BAYOU FALSE, USED AS AN OUTLET FOR THESE LANDS, WITH LEVEE ON RIGHT BANK

cultivation having taken place for a number of years. Steam for the three following pumping units is furnished by two water-tube boilers and one return tubular boiler, crude oil for fuel and a feed-water heater being used.

(1) One 40,000 gallons per minute maximum capacity rotary chamber wheel pump, rope driven from a 16 by 24 automatic non-condensing engine.

(2) One 42-inch by 16-inch Menge pump, connected by a rope drive and a bevel gear to a 16 by 24 automatic non-condensing engine.

(3) One centrifugal pump with 36-inch diameter discharge pipe, direct connected to a double vertical engine.

Pumps 1 and 2 discharge into open flumes at an average head on pump of about ten feet, which is about five feet greater than is necessary. Pump 3 has a siphon on the discharge pipe, but the end is not always submerged.

The pumping plant, with the main reservoir leading to it, is illustrated in Fig. 2, while Fig. 3 gives an interior view of the pumping plant. The direct-connected centrifugal pump appears in the background.

Smithport Planting Company Tract—647 Acres.

This tract, adjoining the village of Lockport, La Fourche Parish, has been recently reclaimed, a large portion of it from Fields Lake. Although it is all drained by well-made lateral ditches placed 200 feet apart, but a small part was put under cultivation previous to 1909. The tract is well shaped and one well adapted to a regular layout of ditches. In this respect it has the advantage of either of the other two plantations.

The pumping plant consists of two Menge pumps with impellers of 32 inches by 12 inches and 24 inches by 8 inches, running respectively at 230 and 330 revolutions per minute. Each pump is rope driven by a slide-valve non-condensing engine, while steam is supplied by a 100 horse-power return tubular boiler, no feed-water heater being used.

District No. 2—940 Acres.

Located five miles west of the village of Raceland, La Fourche Parish, this plantation is as yet only partly under cultivation and the system of ditches is not complete. On account of a very thick top layer of humus of only partly decayed vegetation, good drainage is secured with lateral drains spaced several hundred feet apart instead of at distances as shown on the map (Fig. 1).

Two 42-inch by 12-inch Menge pumps are used, one belt driven and the other rope driven by two 12 by 16 slide-valve non-condensing engines. Two 60 horse-power locomotive-type boilers furnish the steam.

Fig. 4, a typical marsh scene, shows the wild grasses common to this section. It is a view of a portion of District No. 2 before reclamation. Fig. 5 gives a view of the same district after reclamation, showing the levee as constructed, and also Bayou False, which serves as an outlet for these lands as well as for the new tract adjoining them, which is described later.

Fig. 6 is an excellent view of a modern Menge pumping installation at La Branch, La. It is very similar to that installed for District No. 2 near Raceland.

New Orleans Land Company Tract—1,380 Acres.

Although inside the city limits of New Orleans, this tract has but recently been inclosed by protection levees. Originally heavily timbered with cypress and gum, there are still many of the small trees standing, and thus far only a few main canals have been dug. These canals vary in width from fourteen to forty feet, and interior lateral ditches will be constructed later. Drainage is secured by gravity into the city sewer system, and thus this tract differs from the other three in requiring no pumping installation.

District No. 3—2,400 Acres.

This is a new project lying between Raceland and Lake Fields in La Fourche Parish, and it embraces the latest practices as to ditch arrangement and modern pumping equipment. The soil is typical turf land and the surface elevation is 3 to 6 feet above mean tide. The reservoir canals are 40 feet wide and 6 to 8 feet deep, and the collecting ditches have a bottom width of 2½ to 3 feet and a depth of 4 feet. The laterals are spaced 210 feet apart and are made 3 feet deep, with bottom widths of 1½ to 2 feet. The pumping equipment consists of two 30-inch Lawrence centrifugal pumps discharging under water, so that the lift varies between 2½ and 5 feet, according to the stage of water in Bayou False, which takes the discharge. Direct-connected to the pumps are two 100 horse-power vertical engines, steam being supplied by two locomotive-type boilers.

MEASUREMENTS OF RAINFALL AND RUN-OFF.

The calculations of run-off were made from the logs kept at the various pumping plants, each pump having previously been rated. Most of the discharge flumes are rectangular in section and open at the top, permitting the use of weirs for making measurements of the water pumped. These measurements were simplified by the fact that each pumping unit was equipped with a separate discharge flume. Pumps discharging through pipes were rated by means of a Pitot tube.

The run-off from the New Orleans Land Company tract was obtained by means of weir measurements. A 4-foot weir is placed in the main ditch and discharges into a flume, which in turn empties into the drainage canal leading to city drainage station No. 7. The weir and flume are covered by a small tent house, in which is located a recording gage or water register. The cross section of the canal is large back of the weir, insuring complete contraction, so that the measurements are unusually accurate and the Francis weir formula applies. Two rain gages are now located on different sides of the tract and the mean of the records is used in calculations of rainfall.

Records were kept continuously from June 1st, 1909, to January 1st, 1910, with the exception of those of the New Orleans Land Company tract. These latter started June 16th, but were interrupted on September 20th, 1909, by a breaking of the city levees and the consequent shutting down of the city's pumping plants, due to the severest hurricane known to this section, sweeping in from the Gulf of Mexico. Backwater from Lake Pontchartrain and the accumulation of the city drainage water prevented normal conditions from being established till October 9th, when the records were continued.

As the investigations cover such a short period of time, care must be exercised in making deductions from the results. The records are still being continued, however, so that more reliable conclusions can be made at some later time.

During August the pumps in District No. 2 were operated on ten days, although the actual amount of run-off was small. This was due to the fact that it was desired to maintain a certain stage of water to insure the successful operation of a hydraulic dredge which was engaged in clearing and deepening the reservoir canal.

The data which have been collected would indicate that a much greater run-off may be expected from the better ditched and fully cultivated lands than from those that are more nearly in a natural state. While this may be true, it is probable that a long series of uninterrupted records will show a less striking variation. The records on the New Orleans Land Company tract did not begin until the effects of a 5-inch rainfall of the first part of June had passed, and they were suspended during and after the severe storm of September 20th, thus not including the heaviest storms of the season, with the exception of that of December, when the rainfall was heavy and mostly fell in a few hours' time, thus giving the largest percentage of run-off of any recorded. The decreased evaporation of December no doubt also increased the run-off."

Owing to the fact that at times of extreme high water a few acres are drained by gravity on the Willswood plantation, it is probable that the run-off records for that tract show a slightly less quantity than they should.

The fact is well known that very heavy storms cause a larger percentage of run-off than smaller ones, but for storms of all magnitudes there is a variation in the ratio of run-off to rainfall, due to the varying conditions of the soil and to its character and state of moisture, the duration of the storm, amount of evaporation and seepage, slope of ditches and fields, and arrangement and capacity of reservoirs, manner of pumping, and probably to other causes not yet determined.

Excepting as affected for short periods by rains and by pumping, the height of water in the reservoir canals represents fairly accurately the height of ground water of the lower lands. This is notably true of the Willswood tract, where the lowlands are porous and allow a quick adjustment of water level following a change in level in the canals. As an indication of the effect of evaporation, including the transpiration of the vegetation, the record for the month of July is especially interesting. The month was begun with the soil well moistened by showers late in June, yet with a precipitation of 1.17 inches from July 1st to 19th there was a rise of only 2½ inches in the reservoir, while from July 5th to 19th, with a precipitation of 0.99 inch, there was an actual lowering of the water level in the canal.

A few records of pumping operations are available, but the lack of essential details makes them of little value for the purpose of the calculation of run-off. An approximate idea can be gained, however, as to the amount of pumping necessary in order to maintain the water table at the proper height for profitable cultivation. A daily pumping record of the Willswood plantation for 1907 and 1908 has been compiled by Mr. Shaw from the diary of the engineer in charge of the pumping plant. Comparing the two years, it is found that during 1907 it took 14.8 hours pumping for each inch of the 66.32 inches of rainfall, whereas in 1908 the pumps ran 12.9 hours per inch for the 51.06 inches of rainfall in that year. This on its face would seem to indicate that the uneven distribution of the rainfall throughout the year, as well as the fact that one part of the plantation may receive a very heavy precipitation during certain storms while only a small shower may affect the rest of the land, has but slight effect on the general yearly average, and that year by year the ratio of the necessary pumping to the rainfall will be fairly constant.

The mean annual rainfall at New Orleans amounts to 57 inches. There is a slight increase in precipitation in the extreme southeastern part of the State, while it drops off to about 50 inches at Cameron, which is in the western part near the Gulf coast. At Shreveport, about 200 miles from the Gulf of Mexico, the average precipitation is 46 inches.

(To be continued.)

The Mercadier System of Multiplex Telegraphy

The new Mercadier system of multiplex telegraphy showed very good results in tests which were made between Paris and Lyons not long since. Only one wire was used, with a ground return. It will be remembered that several transmitters are used at once, each producing a wave of a certain pitch, so that all the waves are sent at once over the wire and are selected at the far end by vibrating diaphragm selectors, each tuned for only one pitch. Signals are sent by an ordinary Morse key for each transmitter. Professor Mercadier adapts it specially to rapid printing telegraphs, Baudot, Hughes or Wheatstone or Morse registers, such as are used in Europe. In the Paris-Lyons experiments there was used a quadruple Baudot printing telegraph working on direct current. In addition to this there was connected the Mercadier apparatus applied to six Hughes printing telegraphs. Wave currents were used here on the wire, but the Mercadier relays translated these into direct current signals with local batteries, so that the printing telegraphs could be thus operated. In this way the quadruplex Baudot printers worked with direct current on the live wire, while the same wire carried six kinds of vibratory current, each sending its own message to one of the six Hughes printers. This greatly increases the capacity of the wire. The new apparatus is designed so that it is very simple and is easily worked.

French Studies of Insecticides

We already had occasion to mention some researches made in France upon applying insecticides to plants, and it is shown that special attention must be given so as to have a liquid which will wet the surfaces, such as insects, etc., properly in order to be effective. For use upon leaves of plants this is also true, as the proper wetting increases the adherence and it thus favors the penetration of active matter, such as copper salts, into the leaves. For insoluble substances, such as arsenate of lead or copper, capillary attraction gives a closer adherence, and this is more durable. More recently M. G. Gastine shows that the wetting can be obtained not only with soaps, but also with the saponines, which are better than alkaline soaps, as they are not decomposed or precipitated by certain bodies, so that they can be used where soluble soaps cannot be employed. Numerous plants contain saponines, such as Quillaya, Saponaria, Nielle and others. An alcohol solution of Quillaya has been used for making emulsions of medicinal substances like resins or balms. But there is an Algerian fruit which contains a large amount of saponine, and this is the Sapindus, a tree cultivated for a long time past. The fleshy part of the fruit has over 50 per cent of a saponine which is very soluble in water and alcohol. Insecticide liquids can be made of it which give a very good adherence, also emulsions can be made without needing alcohol, and these are very stable. The author prepared specially different emulsions of tar oils or crude petroleum. These oils are officially prescribed in Italy for use in destroying an insect of the small cochineal kind which is of Japanese origin and is very dangerous (Diaspis pentagona). It attacks fruit trees of different kinds, and also flowering plants. In winter there are applied 7 per cent emulsions of tar oils or crude oil, so as to act on the adult female insect, which is well protected and hard to penetrate. The young insects are easily killed by 2 per cent emulsions. However, in spite of the fact that salt solution is

used so as to bring the density near that of the oil and flour is added to flavor the emulsion such products are unstable, and if not well shaken the oil separates out quickly The oil, however will destroy the buds of the plants. Soaps will gave stable emulsions but it was found in Italy that these could not be used as the soaps lessen the poisonous action of the oils The author made good emulsions with Quillaya and Saponaria, etc but the Algerian fruit is especially good A small quantity of the powder will emulsify a large amount of tar oil and the emulsion is so fine that it passes through filter paper Under the microscope it resembles milk Copper salts can be added to tar oil and crude oil emulsions and this is excellent for use against the above insects and also Aphides as well as parasite growths Water 10 liters sopindus powder 20 grammes neutral acetate of copper 100 grammes

Eugenics and Genetics*

"Good Breeding" and Its Significance

By G Clarke Nuttall

The terms are new—the problems they stand for are as old as Cain and Abel And yet it is well that the nomenclature should be of to-day for these terms represent the points of attack at which we of the present with the latest weapons of modernity are attempting to storm the hitherto impregnable strongholds of the mysterious heritage of the children of men

From the beginning of time such questions as to why the son is like and yet unlike the father why and how it comes about he may have say his father s hair with his mother s eyes and the character and personality of a great uncle or yet more puzzling why in a family marked by a strong unity of characterization one child may be strikingly dissimilar to all the rest have forced themselves with bewildering fascination upon all who have stood aside to consider for a moment our common humanity while the deeper problems of the inheritance of moral traits and defects and within what limits moving among hereditary influences free will can act are points that have pressed upon the thinkers of mankind with an almost unbearable burden Hence this present generation with its mind set on keen scientific inquiry was necessarily bound to approach this illimitable field of research into which explorers have as yet pierced so short a distance and it is interesting to note the two chief roads by which it is setting out in its quest the one road being known as the Eugenic and the other as the Genetic

Now Eugenics (literally good breeding)—a term already familiar enough among a small and select school of thought but practically unknown to the commonality at large—is defined as the study of agencies under social control that may improve or impair the racial qualities of the future generations either physically or mentally It is the science which deals with all the influences that tend to improve the inborn qualities of a race and its aim is to influence by every possible means the useful the sane in the fullest connotation of both mental and physical health—in a word the *best* classes in the community—to contribute more than their proportion to the next generation and, incidentally of course to discourage in every way the degenerate the unfit from perpetuating their weaknesses Obviously then there is in Eugenics in addition to the ordinary study of the well worn problems of heredity a large ethical element and it is this element this definite appeal to the common conscience to bring moral laws into a sphere hitherto singularly outside of them that stamps this science with the impress of to-day It is this feature that is the special product of our time and we owe its inception to the genius of that veteran student of human problems—Francis Galton

Genetics on the other hand contains no element of ethics *per se* within it for it is purely an inquiry into the physiology of heredity and variation It examines the ultimate physical elements of life it records processes, it seeks to discover and tabulate the laws that govern them Good bad and indifferent stocks are all alike in its eyes, for all afford suitable material for research to the student of this science Genetics merely cares how things *as they are* happen it carries no ideal other than the acquisition of knowledge before it Therefore while the aim of Eugenics is the realization of an ideal in the future the aim of Genetics is pure knowledge of facts in the present. Genetics, therefore, is the handmaid of Eugenics, for the Eugenist will take the facts that Genetics provides and use them in the furtherance of his aims Curiously enough while Eugenics is the child of a living scientist, the source of inspiration of recent Genetics is a dead monk—the Abbot Mendel of Brun He, working in his monastery garden fifty years ago, was dead and forgotten for twenty years before his writings were found but then so instinct with vitality were they that they had only to be placed in suitable soil for a veritable tree of knowledge, a new science to spring from the tiny grain he had planted so unobtrusively many years before

Both Eugenics and Genetics exhibit phases of novelty hitherto undreamt of and react one upon the other Genetics has presented startlingly new conclusions before us, and has brought into discussion facts that had become practically axiomatic in their acceptance while Eugenics has placed in the moral sphere considerations that have hitherto been received as nature and therefore not to be questioned Let us then pass in review some of these phases

Now it is absolutely amazing how callous the social conscience of the ordinary person has become upon the moral issues raised by Eugenics Even the most flagrant transgressions are condoned The following anecdote is but a sample of general experience The present writer had occasion to visit at times a small house where the door was always opened by a little household drudge of the poorest description A dwarf of poor mentality her lack of intelligence had a peculiar weirdness given it by an appalling squint One day she was missing and an inquiry after Eliza elicited the surprising information that she was married An expression of dismay was met by the retort from her acquiescent mistress That it really did not matter for he was no better than she He proved to be a weak minded youth who could just earn a scanty wage of 10s a week by blowing a church organ By this time indignation was boiling over and a forcible remark on the iniquity of the mistress allowing such a marriage was met by the offended retort that It couldn t in no way be wrong for they were married in church And that was the last word What more could one say? Not only are such marriages sanctioned by our common morality but they have actually the blessing of God called down upon them by His appointed minister! And yet there is not one decent minded person who if he will but stop and think it over does not turn in disgust from the very idea of such a marriage

It is to meet cases like this—better and worse—and many similar problems that the Eugenist is setting himself to work for he has been converted to the fact that the law of inheritance is as inevitable as the law of gravity and moreover that psychical characters are inherited just as surely as physical A notable work in driving this fact home has been done of late by Karl Pearson who examined a large number of children from the point of view of both physical and psychical characteristics Thus on one side they were scrutinized as to their heritage for health eye color curliness of hair cephalic index head length head breadth etc and on the other side for vivacity assertiveness introspection popularity conscientiousness and the general conclusion arrived at was that both physical and psychical characters in man are inherited (within broad limits) *in the same manner and with the same intensity* Again with regard to insanity and pathological defects generally the same rule holds good—they are inherited in precisely the same manner as are the physical and psychical characters

Now since we are shown to inherit our parents conscientiousness shyness and ability even as we inherit their stature forearm and span the Eugenist goes a step further and points out that when we come to the bedrock of things all moral health like physical health all goodness probity capacity and the like together with eyes and hair and stature are an inheritance— Bred not created A question of breeding not pedagogics Of course if the germs are there to begin with they can be quickened by religion encouraged by environment and directed by all the wonderful resources of education moreover the will is free to stimulate or stifle as the man desires but nevertheless the main contention is that no amount of moral effort no excellence in teaching, will evolve what is not there—"The creature is not made but born

Since qualities (or no-qualities-at all) of the intellect come under the same ruling the Eugenist challenges some of the latest of our philanthropic movements For instance the efforts now being made to deal with the slightly deficient—both morally and mentally—the attempt to screw them up to the normal and keep them there—heart breaking work for all engaged upon it—is work which, it is pointed out is not only useless but positively harmful In the past the weak and unfit were allowed to go to the wall, trampled out of existence, the lunatic treated as a criminal and the survival of the fittest was the only law Then came a revulsion against the cruelty and unreason of it all a higher ethical standard was set the law of kindness asserted itself and the weak the unfit the insane were protected but the movement went too far—it o'erleaps itself and falls on the other side for it began to form classes under specially trained teachers with the express object of dragging up the feeble people so that they could enter on better terms in the race of life and but alas! never truly compete for from the outset they are foredoomed to ultimate failure and the course has been strewn with the ill starred wreckage NO the Eugenist insists that the weak and defective are not to be dealt with in such a way that for the few best years of their lives when their capacities are at their highest they may be able to lag along not too remotely behind the average folk and thus earn a pittance and meanwhile incidentally leave a legacy of equally unhealthy equally deficient children to the nation These classes this philanthropy is socially unsound and immoral if that is what it does

Pity and help the weak but remember that it is a national evil when any charitable or social institution allows the indefinite multiplication of the unfit in mind and body says Major Leonard Darwin Instead the Eugenist urges these efforts should simply aim at separating out of the vast number of school children those who are distinctly below the normal in intelligence distinctly lacking in moral sense and after careful consideration over a period of time place those judged undesirable on one side saying The strain from these poor children shall never vitiate the stream of our national life the degeneracy the pollution they exhibit shall as far as they are concerned die with them They shall not be treated as if they were responsible for their deficiencies their lives shall be made happy but they shall run under definite discipline and within definite bounds they shall have as it were the freedom of a large and pleasant garden which is however shut off from the outer world by an impregnable fence In several parts of the country the Eugenic spirit is providing little homes upon these lines In one recently visited by the writer there were about a dozen girls all of whom were defective and yet not one of whom was bad enough for an asylum In an ordinary way such a girl would have lived at home supported or half starved as the case might be the drudge of the house the butt of those around a trouble to relatives a misery to herself with the almost inevitable result of eventually landing in the maternity ward of the workhouse and mother child brought into the world to carry on the heritage of misery sin and defectiveness But here in Sunnyside they were in a happy home with simple tasks and games cheerful pictures and the simplest but brightest surroundings all directed by a firm but kindly matron—prisoners indeed in one sense but prisoners with no sense of bondage no desire for freedom And the State is the gainer for the lopping off of a diseased limb from the community the poison flow is checked

It is confidently asserted that feeble mindedness could be practically stamped out in two generations if the State rigorously determined to check the perennial flow of the strain of the unfit into our national life The cost of establishing homes for the feeble minded throughout the country is often demurred to but granted that it is great would it not pay a hundredfold in the end? And indeed it is rather a rearrangement than an increase of expenditure that is needed for practically all these cases come upon the Poor Rates in the long run when parents or relatives die They cannot support themselves and there is in addition the double heritage from those years of freedom of children to follow their parents for on an average each degenerate has one child as degenerate as himself or herself and others in whom the taint is latent but liable to appear in a succeeding generation The taint of degeneracy in our population is now alarmingly great and threatens to increase indefinitely under our present policy of encouraging the unfit So that the Eugenic Education Society lately formed to call attention to this most

* Reproduced from Fortnightly Review

pressing question is in the forefront of reform movements of the day in attempting to meet that great need as set plainly forth in the report of the Physical Deterioration Committee, when in 1904 it stated The committee are impressed with the conviction that some general educative impulse is in request which shall bring home to the community at large the gravity of the issue i e physical deterioration and the extent to which it is within individual effort to promote and make effective the conclusions of expert opinion

One thing is certain the ordinary man and woman of to day is in a fools paradise with regard to this question They contentedly pass it by as not concerning them at all as not quite nice for their consideration And yet at this moment our country is at a most critical time It is an open secret that the intellectually strong the best of our national life are not adding their full quota to posterity they hang back from the responsibility they shrink from the pressure of adjusting ways and means For the last forty years says a student of the subject the intellectual classes of the nation enervated by wealth or by love of pleasure or following an erroneous standard of life have ceased to give us a due proportion of the men we want to carry on the ever growing work of our empire to battle in the fore-ranks of the ever intensified struggle of nations On the other hand the degenerates the feeble the hangers-on of the strong fostered by false sentiment are adding more than their due share thus intensifying the discrepancy and— The ultimate result is in no doubt We have two groups in the community one parasitic to the other The latter thinks of to-morrow and is childless the former takes no thought and multiplies It can only end as the case so often ends the parasite will kill its host and so ends the tale for both alike

If then Eugenics the influencing of the hereditary forces that are molding our national life is to-day of such primary importance all knowledge which can help in this great work is of no less importance as has already been pointed out and Genetics is far and away its most serviceable handmaid In a sense Genetics represents the material side of the question It attempts to show precisely *how* powers and faculties are transmitted what cells are engaged what physical elements carry the inheritable properties from generation to generation

Already Mendelism—and Genetics to day is largely Mendelian in its lines of work—has brought some striking facts to our knowledge For instance it has absolutely revolutionized our idea of what is known as pure bred Now in pre Mendelian days our conception of a pure-bred individual was one who was descended from a long line of ancestors all of whom were of the same type and as a consequence of which the individual in question more or less nearly approached it But now we know that purity of type in no way essentially depends upon continued selection In certain cases a pure bred individual may result from parents both of whom are cross bred which is a paradox and moreover that the descendants of these individuals will be absolutely pure bred henceforward for all time as long as no new element is introduced later How this can happen must be sought for in that wonderful discovery of the segregation of gametes which is Mendel s priceless legacy to the world It is not the place in this short paper to go into the technicalities of Mendelian hypothesis but the underlying idea may be roughly summarized as follows

Each individual is made up of a large number of distinct characters contributed from two sources i e from its two parents in respect to any of which he may have received two similar portions or two dis similar portions one from each parent. But one or other of the parents may be lacking in some of the characters in which case he will receive a character from one parent and nothing corresponding to it from the other either like or unlike Further to use an Irishism any particular character may be absent in both parents and therefore necessarily represented in the offspring also by its absence Now the offspring will be pure bred for any character if it receives it alike from both parents or does not receive it at all it will be cross-bred if it receives it unlike from both parents or receives it only from one parent and not from the other If neither parent possesses a certain factor at all then none of the offspring will have it if both parents have it then all the children will have it if one parent has it and the other has not then on an average half the family will have it and half be without it

A second most important fact that Mendelism has lately pointed out is that it is in the *second* generation from the parent the grandchildren so to speak —in which we must look for the possibilities that may result from cross breeding There all types possible from that particular cross will be found It has been ignorance of this law that has been chiefly responsible in the past for the disappointments of breeders of both animals and plants

Again all sorts of interesting side-lights are being thrown upon our knowledge of biology, such as, for instance that in the flowers of certain stocks the pollen—the male element—is all of one type, while the egg cells—the female element—carry either the quality of doubleness or that of singleness Then too in the question of the nature of sex the interesting suggestion is now put forward that the quality of femaleness is a definite Mendelian factor following ordinary Mendelian rules, while maleness is a condition due to the absence of this quality

Although so far Genetic conclusions have been principally based upon research confined to the realms of plants and the lower animals owing to the difficulty of treating human subjects and the length of time observation required in their cases yet sundry successful excursions have been made into human affairs and the descent of certain abnormalities and defects has been brought under law Of the law of transmission of normal qualities little is yet proved or in fact attempted Eye coloration is one quality however that has recently been successfully dealt with Here it has been shown that parents whose eyes are without any brown pigment at all i e blue or gray eyes can only hand on to their children blue or gray eyes while those parents who have any brown pigment in their eyes may hand on to their children both brown eyes and eyes without it namely, blue or gray But even if progress has not yet gone far at any rate sufficient has been done to show that man can control his heritage far more effectually than he dared once to suppose

The Eugenists and the Mendelians do not in these early days always see eye to eye in their statistics or in the whole of their policy Thus Prof Bateson, one of the leading Mendelians of the day believes that while the elimination of the hopelessly unfit is a reasonable and prudent policy for society to adopt any attempt to distinguish certain strains as superior and to give special encouragement to them would probably fail to accomplish the object proposed and must certainly be unsafe and referring to some of the Eugenic ideas already set forth earlier in this article he continues Their proposals are directed in the belief that society is more likely to accept a positive plan for the encouragement of the fit than negative interference for the restraint of the unfit Genetic science gives no clear sanction to these proposals Still he joins issue with them in that Some serious physical and mental defects almost certainly also some morbid diatheses and some of the forms of vice and criminality could be eradicated if society so determined And that Genetic science must certainly lead to new conceptions of justice

But in the present embryo state of both Eugenics and Genetics unanimity is not to be expected and definite dogma is impossible and indeed undesirable But the upshot of the whole matter at the present time is that Genetics is working—and apparently along successful lines—to bring law and order into the inchoate mass of the facts of heredity while Eugenics is striving to lead man to use his conscience as well as his intellect in dealing with his knowledge

A Great German Barrage

THERE is being built in Germany a great barrage which forms a storage lake of very extended area in order to supply the new Rhine-Weser canal especially the section of the canal leading from the Ems to the Weser stream However as the canal takes a large supply from the Weser and it is desired not to interfere with navigation on the stream on that account an extra supply is needed so as to come into use to bring up the level of the Weser during low water stage and give the needed flow for the canal A great barrage is to be erected across the valley of the Eder so as to store up the water due to the winter freshets of this latter stream It is known as the Waldeck Barrage and the artificial lake thus formed will drain off a basin of over 14 000 square kilometers (5 405 square miles) The lake will extend for about fifteen miles above the barrage Three villages will disappear and will be submerged under the lake Its surface will be 1 200 hectares (2 965 acres) and it will contain no less than 202 000 000 cubic meters (264 195 800 cubic yards) The retaining wall is to be 48 6 meters above foundations and is built of stone On the upstream side there will be a protecting sole of reinforced concrete in order to prevent leakage of water under the dam The concrete work will go down below bed rock and thus cover over the junction of the dam with the rock bottom. On the same side there will be applied a three-foot clay flooring over the surface of the valley for a distance of 100 feet. The total volume of the masonry work is 300 000 cubic meters (392,370 cubic yards), and the cost of the work is estimated at $5,500,000 at a low estimate.

Engineering Notes

It is planned to use about 76,000 horse-power in two large hydraulic plants which are to be erected in the South of Switzerland, not far from the Italian frontier This will rank among the large power plant enterprises in Europe It will be remembered that the great Brusio hydraulic plant is located in this region A Swiss company is planning the work and it is proposed to use the Landwasser and Albula streams with the turbine stations erected at Filisur and Bergun

Separation of Oil from Condenser Water by Electrolysis.—The condenser water of steam engines always contains more or less lubricating oil, which is too valuable to be thrown away This oil can be recovered by the Davis-Perret process in which the very stable emulsion which the oil forms with the water is electrolyzed with iron electrodes, after the addition of sodium carbonate In these conditions a basic iron salt is formed which envelops and precipitates the oil globules which are then removed by filtration Ellis finds that the addition of colloidal oxide of iron to the condenser water produces the same result The Davis-Perret separator is useful for clarifying all liquids which are turbid owing to the presence of colloidal or emulsified substances

Farm Engines—The agricultural commission of the French Automobile Club holds a concourse every six years and gives prizes to cultivators who make the best use of gasoline motors for farm work It is especially desired to encourage small plants which are mounted by the farmer himself and show an ingenious use of the motors M Yvonnet Thovareck received the first prize for a very well designed plant where a 1½ horse-power motor can drive no less than nine farm devices such as straw cutter root cutter crusher grindstone circular saw well pump besides various dairy machines. All these are in the same building and are belted to different countershafts This gives him $600 yearly saving M Thiebaut uses a second hand tricycle motor for a thresher and other devices For plants of this kind the commission awarded six teen medals or cash prizes

The Art of Felling Chimneys—An interesting method of felling lofty chimneys is practised in England The originator of this method a Manchester man is credited with having felled without accident more than 100 chimneys which for one reason or another had become useless Some of these were from 200 to 250 feet in height The method consists in removing the stones or brick near the foot of the chimney and substituting an underpinning of wood which is afterward set on fire About two thirds of the area of the base is removed up to a height of 5 or 6 feet so that most of the weight rests upon the underpinning Experience has shown that when the work is properly done the chimney leans slightly toward the side where the underpinning is inserted and when a slight crack appears in the masonry on the opposite side the time has come for the fire to be applied As the chimney falls it partially telescopes in consequence of the shock produced by dropping into the void left by the burned timbers

Explorations in Chaldea

COMMANDANT CROS has been exploring the site of the ancient city of Sirpourla in Chaldea, and found remains of buildings and various objects which go back before the founding of Babylon The part which he uncovered consists of different kinds of constructions which were of practical usefulness such as granaries and like storehouses Water from wells was brought to various places by culverts built of brick and went into a number of basins for industrial use A somewhat unusual find among the storehouses was a large collection of dried fish these being of large size The skeletons of the fish and their scales are still to be seen On the spot were found many stamped baked clay tablets and among these were storehouse accounts which showed that the fish like many other products represented tribute paid to the King's treasury by various tribes these being under the control of the Queen s intendant

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An Artificial Method of Forcing Basket Willows

Basket willow growers can not always find a good market for steam peeled rods and are therefore obliged to peel them in sap To do so requires con siderable work during the spring months when other work on the farm is plentiful and labor is scarce If a grower has a large willow plantation and wishes to peel his rods in sap he is obliged to employ an un usually large force and pay them higher wages than they could get elsewhere, in order to complete the work by the first of June Or he may erect a forcing house hire fewer men pay less wages commence to peel about the first of January which will give him plenty of time to complete the job before the other work on the farm begins

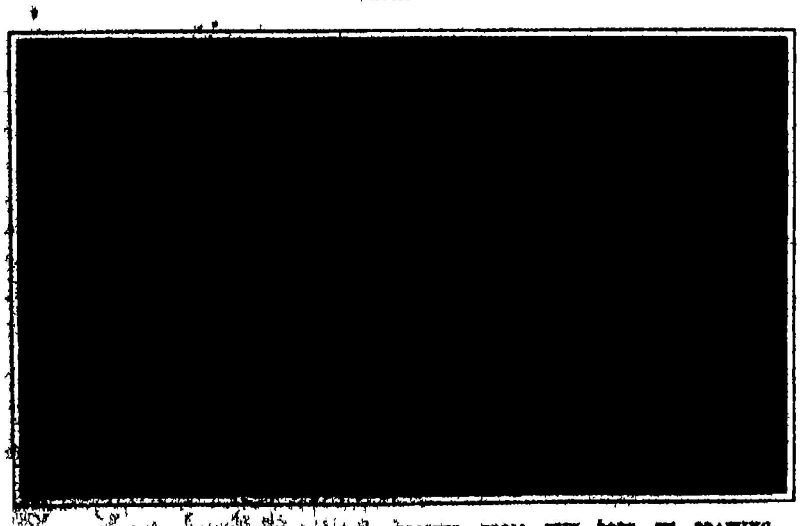
Messrs Lohrig & Odenwald of Balti more Maryland erected a building in which their willow rods are forced to sprout during the winter months at a time when they are peeled in sap The main buildings are located at Laurel Maryland where the firm owns a 60 acre plantation The largest building is about 100 feet long 40 feet wide and 2 stories high The location of the plant is excellent being close to the station of the Pennsylvania Rail road where the peeled rods can be placed on board the cars and shipped to their basket and furniture factories in Baltimore The owners who have been experimenting for nearly eight years have finally demonstrated that this method of treating basket wil low rods is an entire success They are able to har vest and to peel their entire crop by the end of March which is the time when other willow growers com mence to cut their rods The operation has been actively going on with about 40 hands since the first of January "We have the only plant of its kind in America and save a good deal of time and money Mr Lohrig said One of the greatest advantages of this artificial method over that of the natural method of preparing the rods for peeling is the fact that the work can be done during the winter months when labor is cheap and plentiful

Ordinarily willows are harvested in March tied in bundles about a foot in diameter and set butt end down in running water about 4 or 6 inches deep They are left in this position until the sap commences to flow when they are ready for peeling This usually lasts from April 15th to about the first of June In stead however of having only a n onth or six weeks at most in which to do this work Mr Lohrig has over five mon hs t me To erect a suitable b ilding and to equip it for work s exj ensive but the farmer who has 10 a es or more of willows would find t profital le to] t p a for ing l ouse The l d g sh ld be so con str ted that e e y square foot may be tilize l t he best ad antage Tl e best res lts an be a ta n d only if the conditions with n he p ant are as favorable as t ose d ring the bes growing on l i s o ts de f e h ng of first nporta s l e maxi nun amount of gh a l l eat fr l e su and se o d tl]] r f r g be l or p wl l l sl o l nsist f l l fer l e s il abo t n l es dee nde lai l with a] e able on te floor The so l n s l e kept tl or ghl} sat rated with wa er The pit m st l e supplie l w h water at one end wi a run off at the other so that the soil annot turn so r or he water bec me stagnant

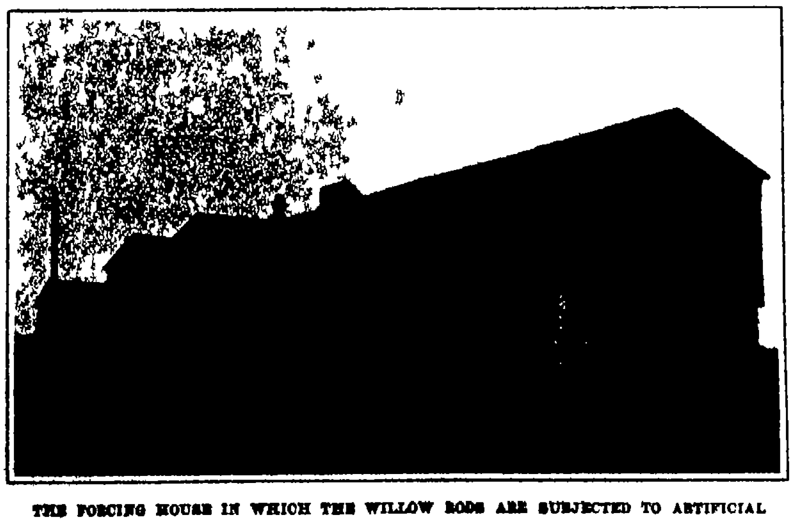
WILLOW RODS BUNDLED AND READY TO BE PLACED INTO THE PIT TO SPROUT

A PORTION OF THE PLANTATION SHOWIN THE FOR NG HOUSE N THE BACKGROUND

PEELED RODS IN THE DRYING ROOM



PEELING ROOM, WHERE THE BARK IS REMOVED FROM THE RODS BY DRAWING THEM BETWEEN TWO STEEL PRONGS



THE FORCING HOUSE IN WHICH THE WILLOW RODS ARE SUBJECTED TO ARTIFICIAL HEAT CAUSING THEM TO SPROUT AFTER WHICH THE BARK IS REMOVED

AN ARTIFICIAL METHOD OF FORCING BASKET WILLOWS

The forcing room in the building here illustrated faces south with a view to derive as much light and heat from the sun as possible and to protect it against the cold north winds To the north of the forcing room is the peeling room and to the west the boiler room The drying room is immediately above the boiler room A building of this kind is kept as low as possible for the purpose of saving in heat The peeling room however is as high or higher than any ordinary working room In Germany the forcing houses are provided with glass roofs which are considered a great improvement over the kind here shown A glass roof slightly slanting would undoubtedly add to the success of the plant especially if provisions were made to cover it with a poor conductor of heat during the coldest nights of the season to prevent chilling the sensitive young shoots The specifications for a building of this kind are determined by the amount of willows to be treated as well as by the local conditions and conveniences at hand The steam required to heat the plant may be drawn from the exhaust pipes of breweries, creameries or grist mills and under such conditions the building and equipment would naturally take on a shape and arrangement according to conditions

An attempt will be made here to give a few facts helpful in planning a forcing house and equipping it properly The forcing room is the most important one and the size of the other rooms is dependent upon this one Since the basket willow plant by nature requires at least six weeks of rest, it is useless to place the rods into the forcing room before December 15th, and it is better not to do so until after the first of January One must not count on more than four months to accomplish this, for the willows commence to sprout in the open as early as April, when there will be no need of subjecting them any longer to artificial heat.

One bundle of willows a foot in diameter requires a square foot of standing room and must remain in this position for at least two weeks before the rods are ready for peeling Two bundles can be forced each month on one square foot, and during four months from the first of January to the end of April it will be possible to sprout eight bundles. It is best to select only the short and medium grade rods to be treated in this way because the long rods sprout much quicker in the open and labor can be secured more readily during the spring for peeling long rods than for the short ones The small rods require more care in peeling so as not to split them and there is more time during the winter to take caution in this respect than during the busy season in spring Less room is also required for peeling the short rods than for the longer ones which may be peeled in the open during the spring months

One bundle of short and middle sized rods weigh approximately 33 pounds and during four months it will be possible to sprout about 264 pounds of green rods which will yield about 66 pounds of dried sap peeled willows. About 75 per cent of the original weight is lost in peeling and drying. In one day of 10 hours a man can peel about 100 pounds of green rods, which amount to about 25 pounds of peeled rods after they are thoroughly dried. At this rate it will take one man 24 days to prepare 600 pounds for market. In 120 working days—the length of the peeling season—he can peel 3,000 pounds, which, in the form of green rods would require a space of 45 square feet in the forcing room. Three thousand pounds of dry peeled rods is an average yield one can expect from an acre of willows Since one acre requires 45 square feet in the forcing room a 10-acre plantation calls for a pit 9 by 50 feet, or 450 square feet.

The space required by one man in the peeling room is about 40 square feet, which has been found to be the best under all practical conditions. If one wishes to save in space required for peeling he can do so by having a night force at work, when only half the space is needed. The boiler room must be large enough for a boiler with a 150-gallon capacity and the necessary room around the boiler for the storage of coal and wood A room 10 by 14 feet will be large enough for a boiler of the above named capacity The drying room must be about 6 feet wide 10 feet long, and about 7 feet high to dry the rods of a 10-acre plantation This room must have a rack 6 feet wide, 10 feet long and 7 feet high which will be large enough to hold all the willows 10 or 15 men can peel in a day

Charles Darwin—II*

The Justification of the Darwinian Theory

By August Weismann

Continued from Supplement No 1843, page 267

In all his descriptions of what he saw his keen appreciation of the beauty and grandeur of nature are manifest Thus he writes from Bahia on the first day of his arrival in South America The day has passed delightfully Delight itself however is a weak term to express the feelings of a naturalist who for the first time has wandered by himself in a Brazilian forest The elegance of the grasses the novelty of the parasitical plants the beauty of the flowers the glossy green of the foliage but above all the general luxuriance of the vegetation filled me with admiration A most paradoxical mixture of sound and silence pervades the shady parts of the wood The noise from the insects is so loud that it may be heard even in a vessel anchored several hundred yards from the shore yet within the recesses of the forest a universal silence appears to reign To a person fond of natural history such a day as this brings with it a deeper pleasure than he can ever hope to experience again (p 4 1884 ed)

Not less delightful are his descriptions of the monotonous and almost endless plains of Patagonia and the La Plata River over which accompanied by Gaucho Indians he rode for many days or his account of the wild mountain scenery of Tierra del Fuego with its gloomy evergreen woods broken into by deep inlets and bays in which whales disported themselves and its mountains whose dark cloud laden summits are swept by the most violent storms A different picture is called up by Darwin s description of his ascent from the Vale of Paradise (Valparaiso) up the Cordilleras to a height of 13 000 feet and the view from there down upon the coast region and the Pacific Ocean far beneath him And how many other passages might be cited'

He cared however not only for what was beautiful but for what was most interesting from a scientific point of view Thus he discovered in a pass in the Cordilleras a stratum of fossil shells a proof that this place was at one time a part of the sea floor and that therefore it had been raised in the course of ages more than 13 000 feet

His journal contains a wealth of observations about plants and animals as well as about man and many detailed accounts of the geological structure of the countries visited We see how well his Cambridge studies and the excursions he made there had prepared him for this work

I cannot enter into any details of his observations but I must at lease mention those which deal with the facts that led him gradually to change his previous views in regard to the nature and origin of species

When he first began his explorations in South America he was as he expressly says still completely under the influence of the dogma of the creation of species once for all and their immutability and he regarded it as unassailable But very soon he was struck by certain facts which seemed to him difficult to reconcile with this dogma and these increased in number in the course of his journey, till finaly they led him to the conviction that the old position was untenable and that the organic world had not been created immutable but had slowly evolved

I select two of these phenomena first the occurrence of the fossil remains of gigantic mammals in the diluvial strata of the great plains of La Plata and Patagonia Darwin found a gigantic armadillo (*Dasypus gigas*) and he was led to ask how it happened that small armadillos now live in South America whereas they do not occur either living or fossil anywhere else in the world The answer was easy if it was possible to assume that the present day species were descended from the diluvial forms or from other smaller still undiscovered forms from the same period But he was especially impressed by the fauna and flora of the Galapagos Islands which lie under the equator 590 nautical miles to the west of the South American coast.

On these isolated and comparatively barren volcanic islands there live many animals which could not fail to arrest the attention of the naturalist—land birds which are like those of the neighboring continent, and those of purely American type yet are not identical but closely related species Most of them are so-called endemic species that is species which occur in no other part of the world This was striking enough but the matter proved even more remarkable on closer investigation for several of the fifteen islands of which the archipelago consists possess species of the same genus peculiar to themselves—mocking thrushes for instance which are represented in the other islands by similar but not identical species

What inference is possible from these facts except that, at some earlier period bird migrants from the neighboring continent had landed on these volcanic islands and in the course of thousands of years had varied that is to say had become distinct species on each island?

These and other phenomena aroused in Darwin's mind the idea of evolution, and he resolved to devote his attention to this problem after he returned home for he was persuaded that he could attain to certainty in regard to it by patiently collecting facts Thus he set himself the task of his life It may be well to inquire here whether or to what extent, Darwin had taken over the idea of evolution from his predecessors at the beginning of the century, and especially from his grandfather, Erasmus. It is certain that at sixteen he had read the "Zoonomia," and that he admired it He relates in his autobiography that, during his student days in Edinburgh Dr Grant, afterward a professor at University College, London, spoke to him in the course of a walk in the most enthusiastic manner of Lamarck and his views on evolution Darwin listened to these views with interest, but was in no way impressed or convinced by them The same is true of the 'Zoonomia, and when he re-read it fifteen years later he was disappointed in it 'the proportion of speculation being so large to the facts given (p 38)

Thus Darwin was quite familiar with the views of his grandfather and of Lamarck, but it was not these that incited him to follow in the same paths, it was rather his own observations of nature that led him to abandon his old opinions and it was only after long years of investigation study and doubt that he gained sufficient certainty to venture on giving his ideas to the world

I must refrain from saying more about this journey which was so fruitful for Darwin himself and for science the two groups of facts of which I have spoken were undoubtedly decisive in their effect on his conception of nature. In December, 1836 with a wealth of great impressions and rich experiences in all the domains of natural science his mind concentrated on the new idea of evolution, Darwin returned to his fatherland after an absence of five years

Two years after his return he married bought the estate of Down, in the county of Kent, and retired there to spend the whole of the rest of his life in constant work but also in constant fellowship and personal touch with the most prominent naturalists of the day, who were readily accessible in London. He gradually came to have correspondence also with many naturalists in other countries.

His "chief pleasure and constant occupation" was his work, which sometimes even enabled him to forget the daily discomfort due to his health, which had been bad ever since his voyage. From the very beginning of the voyage he had suffered from severe and persistent seasickness, and his constitution had apparently suffered lasting injury for in his autobiography he often speaks of being unable to work because of illness, and sometimes of having lost days and weeks, and one one occasion two whole years, from this cause.

In dealing with his work it is impossible for me to speak of all the important volumes he published in the course of his life. The first were the results of his voyage, various geological observations, and a new theory of the origin of coral islands.

Up till that time it had been believed that the so-called atolls, or lagoon reefs, had been simply built up by the coral polyps from the ocean floor until they finally reached the surface, where they formed flat

* An address delivered at the University of Freiburg on the occasion of he Centenary of Darwin Reprinted from *The Contemporary Review*

islands. Darwin recognized that the process could not be quite so simple, because the polyps cannot live at great depths. He therefore assumed that a secular subsidence of the ocean floor must have played a part and this hypothesis not only explains in the most beautiful way the details of the structure of an atoll but it has been brilliantly corroborated by later investigations, especially by borings on one of the islands, and the theory is now a permanent possession of science. After the completion of this volume he worked for eight years at the rich material he had brought from the coast of Chile of that remarkable group of sedentary crustaceans the Cirripedes usually known as barnacles and acorn shells. Two thick volumes on this subject appeared in 1851 and later two other quarto volumes on fossil species of the same group. Even here in this apparently dry and purely systematic province the true spirit of the investigator revealed itself for he did not neglect what was unintelligible to him and therefore inconvenient for his theory but devoted the most persistent attention to obscure points until he had found a solution of the difficulty. Thus he discovered that within the group there are species which like all Cirripedes are hermaphrodite but which possess in addition small degenerate-looking males of different structure attached as parasites to the hermaphrodite animals. It is however only in our own day that it has become possible to understand the deeper significance of this important discovery.

In addition to these special pieces of work Darwin collected with untiring energy facts which had any bearing on the theory of transmutation having begun in 1837 just after his return to England a large collecting notebook in which he entered all the facts referring to the variability of animals and plants in particular of those which are under the care of man. By means of printed lists of questions of conversations with expert breeders of animals and plants and of wide reading in books and journals he sought to lay the foundation of fact which he required in order to attain to clearness in regard to the supposed transformation of organisms.

He was very soon led to the conviction that the essential factor in the artificial modification of an animal or plant form was selection for breeding. But how could such selection take place in free nature? For a long time he was unable to find the answer to this question until chance made him acquainted with the work of the economist Malthus on Population and the ideas developed in this book suggested to him the solution of the problem. Malthus showed that the human population multiplied much more rapidly than the means of subsistence could increase and that therefore catastrophes must occur from time to time to diminish the excessive number of human beings. Darwin said to himself that in the rest of nature among other forms of life also an enormous number of individuals must perish since all that were born could not survive and since the greater part of a species furnishes food for some other species. Thus the ceaseless struggle for existence became clear to him and suggested the question whether it was merely a matter of chance which of the many born should survive and which should perish. He concluded that the answer to this question was evidently that favorable variations would have more prospect of survival than unfavorable and thus he discovered the principle of natural selection—that the principle at once so simple and so powerful which alone enables us to understand the transmutation of organisms in adaptation to the conditions of their life. But it was a long time before Darwin ventured to publish this luminous idea. For his own satisfaction he wrote a rather short sketch of it in 1842 and in 1844 he expanded this to 230 pages but it was not till the fifties that, urged by his friends Lyell and Hooker, he resolved to give his ideas to the world. Even then he might have delayed publication but that in the meantime the same idea had occurred to Alfred Wallace in Ternate in the Malay Archipelago and had been communicated by him first to Darwin and then through Darwin to Lyell and Hooker. Then followed the memorable meeting of the Linnean Society London in July 1858 at which two papers were read one written by Darwin the other by Wallace both setting forth the same far reaching idea of evolution based upon the principle of selection a beautiful example of the unenvying magnanimity of two great discoverers.

This private communication to a scientific society made no great stir. But the publication in the end of 1859 of Darwin's book The Origin of Species by Means of Natural Selection attracted great attention. A new edition was called for on January 2 1860 and during the twenty two years between that time and 1882 the year of Darwin's death one English edition followed another and more than 24 000 copies were printed. During the same period one German edition succeeded another and it is doubtful whether any other scientific book attained to such a circulation.

Yet the book is simple and straightforward never sensational in style but advancing quietly and concretely from one position to another each supported by a mass of carefully sifted facts. Every possible objection is duly considered and the decision is never anticipated but all the arguments on both sides are carefully and impartially discussed in a manner that is apt to seem to the impatient reader almost too conscientious and cautious.

To readers who were acquainted with the scientific results of the time who were aware of the numerous important facts that had been discovered but missed the unifying idea which should gather them all together into a harmonious picture of life the book came as a revelation. I myself was at the time in the stage of metamorphosis from a physician to a zoologist and as far as philosophical views of nature were concerned I was a blank sheet of paper a *tabula rasa*. I read the book first in 1861 at a single sitting and with ever growing enthusiasm. When I had finished it I stood firm on the basis of the evolution theory and I have never seen reason to forsake it.

This must have been the case with many. You know that the generation at the beginning of the century satiated with speculation threw itself wholly into detailed research and its whole endeavor was to acquire new facts. Darwin furnished the unifying idea for these. It was evolution. Almost the whole younger generation of naturalists ranged themselves at once on his side the older generation gradually followed first zoologists then botanists even my excellent friend Anton de Bary was only converted to the new views in 1880 and from that time onward there was little further opposition even on the part of the botanist.

Although Darwin's book was straightforward and simple its effect was nothing less than revolutionary. It upset the old deep-rooted doctrine of creation just as completely as Erasmus Darwin Lamarck and Oken had desired. The book raised a conflagration like lightning in a full barn. This was soon so widespread that people read only against or for Darwin especially in Germany but later also in England. At first the opponents had the upper hand the church regarded the new doctrine as dangerous to religion because the old Mosaic mythus of creation could no longer be regarded as the basis of belief and many of the older naturalists did not care to give up their inherited opinions without a struggle and therefore strove to depreciate the new theory either by serious argument or by satire and ridicule. The first to publish a work for Darwin was the German naturalist Fritz Müller (1864) in Brazil. His book contained the first important deduction from the Darwinian theory. It went further than Darwin himself and contained the germ of what Ernst Haeckel called in his suggestive Generelle Morphologie (1866) the fundamental biogenetic law. I myself was probably the third champion of Darwin's views when in 1867 I delivered my academic inaugural address on The Justification of the Darwinian Theory.

At that period almost every special study in the domain of embryology and comparative anatomy revealed fresh facts which were only intelligible on the assumption that the theory of descent was valid much was now observed that had formerly been overlooked simply because it was not understood and much of the work done in the period of detailed investigation had to be done over again because the points that were now most important had previously been disregarded. In this no reproach is implied to the many excellent observers of that period. No one can possibly observe everything that takes place for instance in the development of an animal each notes only what seems to him to have some significance whether he is able to interpret it or not. We do not work with our eyes alone we must think at the same time.

But I need not dwell longer on the manner in which the Darwinian theory gained over the scientific workers of all countries and penetrated deeply even among the laity. We have all had some personal experience of it for the triumph of the theory of evolution has not long been won. A few words may be necessary as to why it was won so easily and so completely.

This was due in part to the enormous and increasing mass of facts in support of it but mainly to Darwin's discovery of a principle capable of explaining transformations in so far at least as these are adaptations the principle of selection. Lamarck too had thought out a principle of explanation—the use or disuse of parts—but it was obviously insufficient to explain evolution as a *whole* since it could only apply to actively functional organs.

The discovery of the principle of selection is the greatest achievement of Charles Darwin and his contemporary Alfred Wallace and it alone in my opinion at least affords a secure basis for the theory of evolution. It reveals to us how the apparently impossible becomes possible how what is adapted to its purpose can have arisen without the intervention of a directing power.

(To be continued.)

Geology and Our National Resources

In his recent presidential address before the New York Academy of Sciences Prof J A Kemp took up the discussion of some of the problems which arise in connection with the ultimate limitations of our supply in raw materials derived from the earth's crust. The consideration of a number of special aspects of the situation was introduced by some reflections of a general character. Prof Kemp says:

The problems of the production of the metals and non metalliferous substances as we know them to-day are of quite recent growth. High explosives efficient engines and pumps steam shovels and the like are all not so old as many men who are still living. They have so greatly reduced costs that practically a new world has opened to the miner. Not only on the surface or near it has he been able to work but the depths have become accessible and where the value of the ore justified the effort no floods of water have sufficed to keep him out.

"These successes, coupled with ever-expanding markets have until recently directed attention almost wholly toward discovery and production. But the last ten years have brought a further change. We are now less concerned about new discoveries than about the maintenance of old ones. We are not altogether intent on production, but are much given to forecasting and husbanding. From being solely an aid to the miner, the active worker the producer geology has become the colleague and helper of the economist, the statistician and the philosopher.

"Like all other changes in fundamental points of view this one has not come with absolute suddenness. As far back as 1879 certain geologists and engineers began to raise and discuss the question of the duration of the Pennsylvania anthracite. In 1894 the late Richard P Rothwell long the able editor of the *Engineering and Mining Journal* gave these coal fields a future of 70 to 100 years. Thus for over thirty years the question of their death has been a very live one. Even earlier the future of the coal fields of Great Britain came up for discussion. A parliamentary commission was appointed in 1866 and reported upon the question in 1871. For forty years anxiety has prevailed regarding the continued production of our petroleum wells and naturally so. The very means of production of this useful source of heat and light starts a train of thought along the lines of its permanence.

"Some ten years ago the question of our reserves in iron ore began to excite interest. Mr Andrew Carnegie gave most forcible expression to the feeling of alarm in his rectorial address in 1902 at the University of St Andrews Scotland. Mr Carnegie was known from one end of the world to the other as one of our greatest ironmasters and his words made a profound impression. In his address he assigned us only enough first-class ore to last for sixty or seventy years and only enough of the inferior grades for thirty years thereafter. We all trembled for some years with the prospect of seeing our greatest industry in the production of metal disappearing within a century. Many thoughtful people began to wonder what would become of us with its extinction."

At this time when the movement for the preservation of our national resources is the order of the day it is interesting thus to call to mind the past history of the rise and origin of the modern policy.

M Pierre Lesage of Paris states that he is able to show whether certain seeds are able to grow or not by placing *them in potash solution*. The seeds which are defective and are not good for planting are found to give a yellow color to the solution. At present he confined his experiments to one kind of seed the lepidium sativum using old seeds collected in 1888 to 1893 and comparing them with fresh seeds from 1909. He finds in general that the seeds which have lost their growing power will color the potash solution yellow owing to the diffusion of a substance which he has not examined as yet. They do not produce this color in pure water however. As to the time which is needed to give the yellow color this is shorter than what is needed for grains of the same kind to sprout. For instance using the old seeds from 1893 they showed a color in the solution in about four hours while fresh seeds from 1909 took twenty hours to show a sprouting in the same conditions. Thus the process allows of gaining considerable time in observing the seeds. The present experiments are only in the first stages but it will be seen that should we be able to find out at once whether certain seeds or grains are able to grow or not by a simple experiment, the result will be of great practical value. Other kinds of solutions will no doubt be found which can be used for testing seeds or grains in this way.

Reclamation of the Southern Louisiana Wet Prairie Lands—II*

By A D Morehouse, Office Engineer, Drainage Investigations

Concluded from Supplement No. 1843 page 270

METHODS OF RECLAMATION

Early Methods

SOME years ago systematic efforts looking toward the reclamation of these fertile marsh lands began and it is interesting to note that as early as 1883 84 1 300 acres were reclaimed by one company During the great flood of 1884 however the levees were broken and further work ceased for the time Later Mr J B Watkins reclaimed a large area in south western Louisiana and in Tide Marshes of the United States he gives the following description of his methods

O r plan of reclamation is to build dikes along the g lf rivers lakes and bayo s of sufficient height and strength to prevent overflow of each in the event of floods from rain and storm tides and in this we will be assisted by the natural levees found in many places along these waters We cut parallel to each other and one half mile apart canals 18 feet wide and 6 fe t 1] A right angles with these at intervals of 2½ miles we cut larger canals, thus forming the land into oblong blocks one-half mile by 2½ miles each containing 800 acres Across these blocks at proper intervals we cut lateral ditches 30 inches deep by 8 inches wide at the bottom flared to 30 inches wide at the top

The canals are cut the levees formed and the dikes are to a considerable extent built by the use of power f l floating steam dredges Smaller ditches are cut by ditchers propelled by steam power passing through l it once at the rate of 1½ miles per hour

At proper localities we erect automatic flood gates by means of which we control the stage of water in the canals and the necessary volume of water is regulated to some extent by the ebb and flow of the tide This is supplemented by the use of powerful wind pumps and when the natural elements will not accomplish the work we readily move upon the canals to the spot our ditching plowing and cultivating engines and attach them to pumps Thus arranged with control of the water these blocks of land are in condition for the most successful rice culture

In the rice and sugar belt in the southern part of the State the land ranges from 2 to 8 feet or more above mean gulf level and the swamps bayous bays and rivers with which the section is interspersed furnish the outlet system by which the drainage water may be carried to the gulf In a majority of cases it is necessary to levee a part or all of a plantation in order to protect it from the overflows in times of flood and also in regions near the gulf coast to protect it from backwater and high tides especially at times when the prevailing southeast winds are blowing At such times the waters along inland streams the ast n ay be raised as much as from 3 to 5 f fron l is a so In this connection might be lo d the fact that on the Matthews plantation in La l our he Parish it was considered that usually the p[illegible] s had to operate only after a rainfall of 4 inches or more in twenty four hours but when the southern wi s made high tides in the bayou they were started f r as small as a 2 inch rainfall

FIG 9—SAME VIEW AS FIG 8 BUT SHOWING RESERVOIR CANAL OF DRAINAGE DISTRICT DAMMED ACROSS AND PUMPING PLANT BEING ERECTED

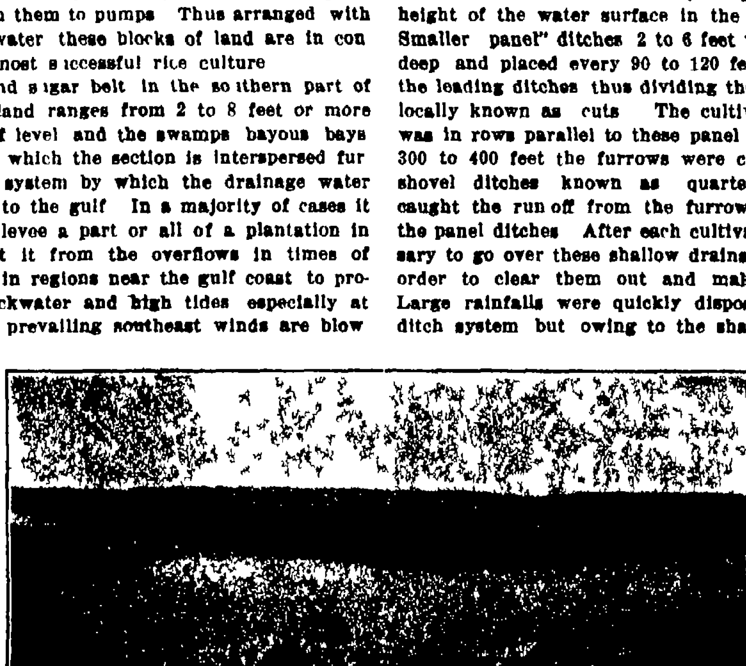


FIG 8 CONSTRUCTED CANAL SERVING AS OUTLET FOR TWO DISTRICTS AND AFFORDING GOOD TRANSPORTATION FACILITIES

Until very recent years the ditch systems for the reclamation of sugar lands were nearly identical Often it seemed that the chief effort was simply to rid the land of the rainfall without much regard as to whether or not the drainage of the soil was secured. As most of the plantations ran from the bayous or streams back into the swamp there was usually at least a slight fall away from the streams and a series of parallel leading ditches from 6 to 10 feet wide and 2 to 4 feet deep spaced from 800 to 1 200 feet apart ran the length of the plantation These were intersected at right angles usually by ditches of similar size at distances of 800 to 1 200 feet apart These latter ditches were laid with no fall so that the water would flow either way dependent upon the height of the water surface in the leading ditches Smaller panel" ditches 2 to 6 feet wide 1½ to 3 feet deep and placed every 90 to 120 feet, ran parallel to the leading ditches thus dividing the land into blocks locally known as cuts The cultivation of the crop was in rows parallel to these panel ditches and every 300 to 400 feet the furrows were crossed by shallow shovel ditches known as quarter drains which caught the run off from the furrows and led it into the panel ditches After each cultivation it was necessary to go over these shallow drains with a shovel in order to clear them out and make them effective Large rainfalls were quickly disposed of by such a ditch system but owing to the shallow depth of the ditches the drainage of the soil was not as effective as under more modern systems, and from 10 to 20 per cent of the cultivable area was taken up by the ditches besides the inconvenience caused by the smallness of the plats to be cultivated The cost of such a ditch system not including levees or pumping equipment would amount to over $2 000 for 80 acres or an average of over $25 per acre

PRESENT METHODS.

It is apparent from the experiences of the past that in the reclamation of small areas of land the cost might often be prohibitive, but as the size of the plantation increases the cost per acre rapidly diminishes and probably approaches a minimum price when the plat of ground amounts to eight sections (5,120 acres) of land or more. Under ordinary circumstances however it would be difficult to find such a tract of land lying in regular shape and available for reclamation hence there are few single projects thus far which have attained this size although the impetus recently received in the matter of reclamation of these lands indicates that the undertakings will become larger and larger The various main elements which enter into these projects are the levee system seepage outlet canal system interior ditch system and lastly the pumping plant

Levees and Seepage

Sometimes the natural embankment or high ground adjacent to the bayou or river makes a levee unnecessary along the stream side of the plantation but ordinarily the other three sides need such protection wholly or in part the height of the levees depending in large measure upon the proximity to the gulf and upon the elevation of the land surface respective to the high water in times of flood Ordinarily the levees do not require such careful construction as those along streams subject to frequent and prolonged floods where the water often stands against the embankement for long periods nor is it always so necessary to clean the entire levee site as in this latter case It is always well however to remove all coarse vegetable matter and a plowing up of the site is very desirable in order to insure a good bond. The general specifications for levee construction and maintenance have been given in a previous publication of this Office A muck ditch 2 or 3 feet in width and about 2 feet in depth and approximately on the center line of the proposed levee should be constructed in order to insure against excessive seepage Such seepage is liable to be the minimum in the fine close-textured silt soil back in the marshes In the case of the Gheens plantation La Fourche Paris two parallel muck ditches spaced 25 feet apart are used under the levee

Shrinkage of the levee should also be taken into account and experience would indicate that levees in these soils built by means of shovels or wheelbarrows shrink about one-fifth of their gross height, while those constructed by wheel scrapers shrink one-eighth in height. Where an excavating machine is used in dry material the shrinkage is approximately one-sixth and where excavated material is wet it is probably not more than one-tenth In the latter case the spoil generally being from a greater depth and being well compacted during the construction usually insures less seepage than where hand work is performed and where the levee is constructed from the looser coarser material nearer the surface. In order to prevent excessive seepage it is preferable in constructing the levees to excavate the canals on the outside leaving a sufficiently wide berm to prevent the spoil from sloughing back into the ditches. Unless care is exercised this is especially liable to occur in the soft prairie lands. The levees require for the first few years frequent additions in order to keep them to the required height, unless when first constructed, shrinkage has been allowed for In order to maintain them with as little care as possible, it is well to have them sodded to Bermuda or some native grass which not only prevents them from washing but also prevents the growth of weeds, brush, and other vegetation that

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* This article is based on reports to the chief of drainage investigations by A M Shaw, E New Orleans, La., and Prof W B Gregory M E Tulane University, of their investigations made during 1909 and also upon data furnished by C W Okey, assistant drainage engineer, who continued the work of this Office during 1910 in Southern Louisiana. All quotations not otherwise credited are from the foregoing mentioned reports, the portions referring to pumping equipment being by Professor Gregory and the rest by Mr Shaw

would furnish shelter to the many borrowing animals which, ordinarily, occasion much annoyance and also damage to the levees. The sudden rise of outside waters often endangers levees on account of the increased seepage at such times which is probably often due rather to the more porous nature of the soil above the ordinary water level than to the increased head. Such floods, however develop all weak spots caused by muskrat holes and the like When a failure occurs from this cause the outer end of the break should be immediately closed by a few shovelfuls of clay planks, or sacks of earth and a trench then dug across the levee The tunnel made by the animal can then be filled with puddled clay and the damage thus remedied.

Canal Systems

Where a plantation does not adjoin a bayou or other good outlet it is often necessary to construct outfall canals for some distance often through heavy timber which of course greatly increases the cost of the reclamation work and calls for the co-operation of a number of land owners in order to make the plan feasible These outfall canals as well as those surrounding the levees furnish good means of transportation by boat and often the flow of water from the drainage plant will be sufficient to keep them scoured out so that they require little attention Such transportation routes connecting as they do with a series of lakes bayous and streams place the various plantations in a comparatively independent attitude so even though not furnished with convenient rail road facilities they are still within easy and convenient reach of good markets Fig 8 shows such a canal const uct d as ai utlet for two I ali age dis tricts The small canal shown for us th reservoir of one of these districts and as shown by Fig 9 it has been cut off from the o itfall canal by an earth dam and the pumping plants as appears is it process of erection Along the banks of these canals willows and cottonwoods brush and weeds often grow b t as they are above water level they do not as a rule offer much interference to the flow of the stream Another growth however that causes a great an o int of annoyance and in some cases pra tically stops the flow of the water in the ditches is the water hyaci th which is known locally as a lily It is practically impossible to navigate throigh these obstructions when once well established except by the use of stern wheel power boats These plants introduced from abroad have rapidly spread through many of the southern streams so that means for checking their growth or eradicating them entirely are eagerly sought Fig 7 shows a canal filled with these water hyacinths which have grown to about 18 inches above the water surface The view shows the main discharge canal of a large plantation, and it can readily be understood how its efficiency is impaired by this pest The following description of the plant is taken from a report by F F Shafer drainage engineer

"The plant when young has a bulbous stem but as this grows upward the enlargement disappears, apparently being absorbed by the stem which is cylindrical and hollow The plant multiplies rapidly by sending out shoots or suckers from the base of the bulb the shoots and roots seeming to start from the same place. The latter grow in feather-shaped tufts, presenting a large surface to the water They are tender and break off readily but if not disturbed grow downward 4 or 5 feet In the latter part of May a flowering stem appears which bears a spike of odorless flowers, pale lavender in color resembling the ordinary cultivated hyacinth The stems reach a diameter of one-half to three-fourths of an inch and in this vicinity frequently extend 3 feet above the water surface Crowding does not seem to hinder the growth of the plant and since it floats upon the surface of the water wind tide, and currents tend to produce closely packed masses When a ditch becomes filled with these plants the floating stems and roots offer a very serious obstruction to the flow of water Two or three years of undisturbed growth in a ditch will greatly reduce its usefulness as a drainage channel Booms are placed at the outlets of the drainage canals to prevent the plants from floating into the ditches I it it is difficult to prevent these booms being left open by people passing through in boats

The attempt has been made to use poisonous chemicals for the eradication of these plants this not only proved more or less ineffective but the expense was far too great On the Matthews plantation before mentioned an attachment in the shape of a gridiron some 7 by 8 feet in size was fastened to the dredge dipper and the plants dipped p and d imped on the banks in a similar maner to the operation of a dipper The plants when exposed to the hot sun soon die The cost of removal by this method amo nts to about 0 4 cent per square yard for the area cleaned On other plantations during the rainy periods the laborers use pitchforks to remove the water hyacinths from the ditches If is often necessary to repeat the operation once or twice a m nth Tl e cost in th s ase is practically the same as by tl e use of the n a chine In localities close to the gulf where salt wate prevails the plants do not thrive

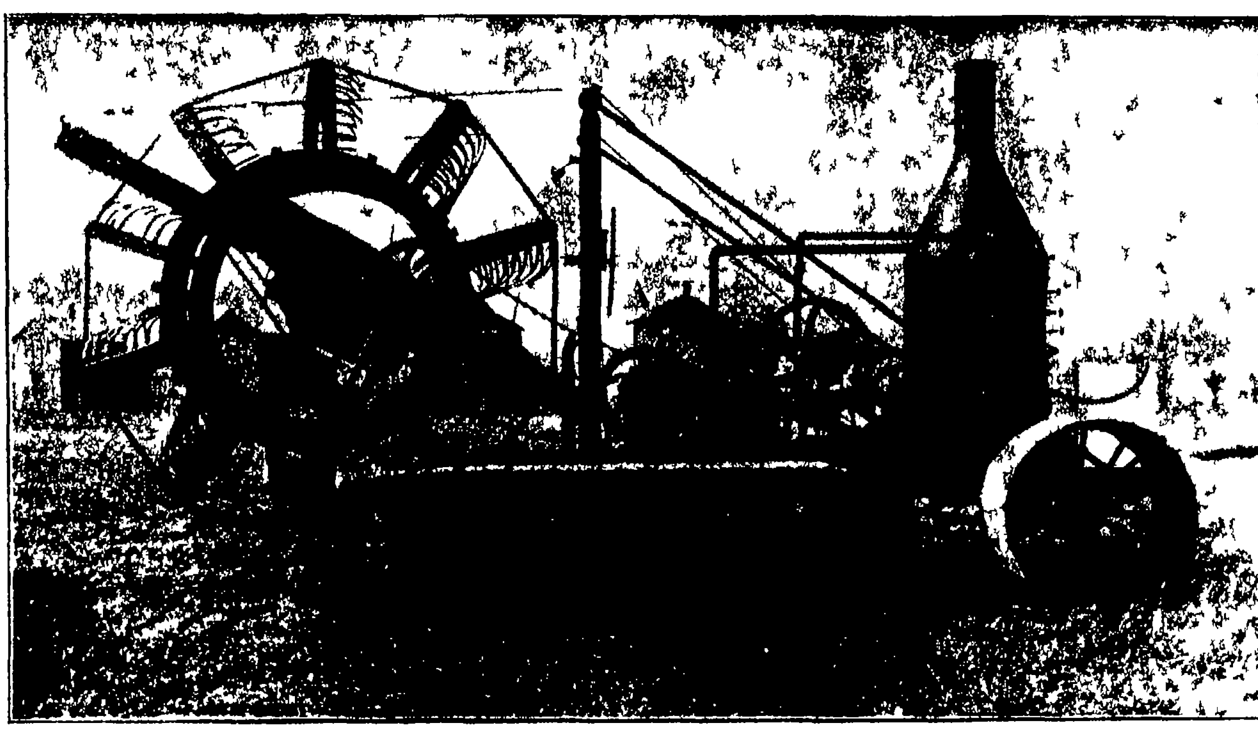
Interior Ditch Systen s

Although somewhat dependent upon the size and shape of the area inclosed within the levees the pres et t general scheme of drainage is more or less the same throughout this region This system usually in cludes a main reservoir canal or canals upon which at some convenient place a pumping plant is installed Leading into these reservoirs are collecting ditches of somewhat smaller size and at right angles to these latter are lateral ditches which are still smaller and which usually feed into the collecting ditches as on the Willswood plantation In certain cases as in the Smithport plantation the collecting ditches are practically dispensed with and the lateral ditches dis charge directly into the reservoirs In addition to the laterals shallow shovel ditches corresponding to the old quarter drains" are maintained at right angles to the furrows and thus collect the water rapidly from the fields and discharge it into the ditch system These latter are made new each year and they vary in arrangement and size to meet the individual requirements

Although subject to variation the main reservoir canals range in width from 30 to 60 feet and usually have a depth of from 5 to 8 feet The deeper the canal the greater storage capacity it possesses and the better outlet it furnishes for the collecting ditches or laterals as the case may be and it is also less liable to water-growth obstructions As shown in the following table, the reservoirs of the three plantations under investigation have varying capacities equivalent to a rainfall on the tributary lands of from 0 1 inch to 0 4 inch It would seem preferable to construct reservoirs having even greater capacity than the larger amount mentioned as by so doing the size of the pumping plant can be decreased This table from Mr Shaw s report besides showing the reservoir capacity also gives the length of the various ditches and area occupied by them and gives as well, the normal capacity of the pumping plant in inches of water depth per twenty four hours It will be noticed that the ditch systems of these three plantations only occupy from 3 to 6 per cent of the area which is a decided decrease from the 10 and 20 per cent nder the old ditching system as previously mentioned

Data of Ditch Systems

I m p	S n hport		W wo		rl N g	
	ng h	Area	g h	A a	rt	a
	M es	Acres	M s	A s	M es	A res
Reservo rs	1 25	6 6	4 98	24 2	00	4 9
b a a	38	9 0	6	24 9	3	0 0
Late a s	20 5	9 5	25 9	9	8 55	18 5
Tota	32 8	30	4 33	40 2	26 86	28 4
P port n oc p ec by d hes p en		4 65		5 84		5 08
apac y res o a fl o stag n ches o a n a o e e e a ea		0 34		8		0 10
Approx mate a capac y of p mp ng l an n hes pe 24 ho rs				5		33



F G 10 —OPEN TRACTION DITCHER USED FOR DIGGING LATERAL DITCHES N WET PRAIR F ANDS SOIL S DEP S TED AT ONE SIDE OF DITCH LEAVING GOOD BERM

Th arrangement of th colle ting dit hes largely depen is up the shape of the fields and tl e nat ral opography of the land and also upon the method and kind of c ltivation th t is desired The endeavor is to arrange them l owever so that they may get the water from the fields into the reservoir canals as promptly as possible They vary from 4 to 10 feet in width and are us ally maintained at a depth of fro 4 to 5 feet

Ordinarily the lateral ditches in heavy soils are placed 100 feet apart and are dug so ne 3 feet deep with bottom width of about 2 feet and a top width of about 4 feet Formerly these laterals were lug en tirely by hand but a litcher machine has been developed which now ligs them with great rapidity as well as economy A view of this machine may be seen in Fig 10 All the larger ditches are constructed usually by floating dipper dredges having 1 or 1½ yard dippers and the present contract price is abo it 7 cents per cubic yard

Thus far drain tile has not been extensively used in this locality as the nature of the soil and the slopes found are likely to introduce difficulties which will have to be overcome before underdrainage is uni versally adopted It is probable that in the coarser looser soils near the bayous and streams tile would be more effective than in the more impervio s silt farther out in the swamps If it can be s iccessf lly introduced so as to supersede in part the se of the smaller dit hes a gain in land area and in convenience of cultivation and in the effective draining and aeration of the soil would be the result By proper care in protecting the joints it is improbable that silting of the tile would give much trouble

As a general thing the water table of the plantations in southern Louisiana is carried at from 1½ to 3 feet beneath the surface and it is well known that the greater depth is preferable as besides furnishing a greater depth for the roots of the growing crop it also furnishes greater reservoir capacity in the soil to provide against excessive rainfall It likewise makes possible a smaller pumping equipment By keeping the pumps running during the winter season when necessary the water table is kept as low as possible aeration of the soil takes place and the soil is thus put in good physical condition

Pumping Plants

Some plantations are so situated that fairly satisfactory drainage can be secured by the installation of outlet gates through the levees either automatic or hand regulated These drain the system of reservoirs and ditches in times of sufficiently low water but when the water outside the levees is higher than the outlet of course the gates must be closed and the reservoirs depended upon to hold all the interior drainage water A great majority however of the plantations which are reclaimed require the installation of a pumping plant in order to make the drainage system effective at all times and make the leveed area independent with the possible exception of seepage of everything except the rainfall These pumping equipments vary greatly according to individual opinions and means but each particular location should be studied carefully in connection with all its surrounding conditions in order to choose an installation whose first cost will be warranted by the benefits received and also one the operating expense of which will be reasonable A balance should also be struck between the economical reservoir capacity and the size of the pumping plant

In years past a machine that has been greatly in favor especially upon the sugar plantations is the drainage wheel This is made of any desired capacity and may vary in diameter up to perhaps 40 feet, with a width of from 5 to 7 feet By proper gearing usually a double reduction the speed can be regulated to suit the case but usually a peripheral velocity of 3 to 4 feet per second is maintained It is probable that a speed of 5 feet is desirable for revolving at a greater velocity the water is liable to be carried over while with a slower one a portion of the water may flow back into the pit. These wheels are placed at the end of the main ditch, and when not in operation the flood gate in the levee is closed When the circumference of the wheel fits closely in a smooth pit with the lift not exceeding one-third the diameter of the wheel and when running at the proper speed such a wheel will handle a large quantity of water at a small cost Although they have been made ordinarily by the individual plantation owners and the actual expense of the material and labor of the wheel itself is not excessive still the large foundations required make them probably more expensive than some of the more modern installations

Another machine sometimes used is the rotary or chamber wheel pump One objection to this form is that for the larger sizes the construction necessitates that the water be lifted about 10 feet and in case the necessary lift is less than this there is lost work They are also somewhat expensive and are limited to their normal rated capacities

The centrifugal pump is especially adapted to varying lifts for by the use of a discharge pipe whose end is submerged in the out fall canal or bayou a siphon effect is produced so that the actual head against which the pump is working is simply the difference in elevation between the waters in the reservoir and in the outlet canal These pumps on account of the varying speed at which they can be operated have discharges for short periods of time far in excess of their rated capacities which is especially desirable in cases of excessive rainfalls of short duration The ordinary type of centrifugal pump made principally of cast iron is somewhat used and can be installed with either vertical or horizontal shafts In the latter case it can be direct-connected with the steam engine

There is a special form of centrifugal pump particularly adapted to low lifts that has been in use for a number of years and is doing most satisfactory work on a great many plantations including three of the experimental tracts It consists of a wide submerged impeller wheel on a vertical shaft driven by belt or rope from the engine The water rises through the large wooden body of the pump flowing away through a wide discharge trough Except the impeller shaft bearings and pulley the entire machine is of wood. This pump is of large capacity and is perhaps especially adapted to lifts up to 10 feet, although it is claimed that by the use of two or more wheels, set one above the other, water can be pumped against a head of 40 feet The discharge trough or platform can be placed at any height required, If it is set at high water mark however there would always be some waste of power when the water in the bayou or out-fall canal is less than this height

As the necessary water lift in the plantations of this section varies from 3 to 10 feet, it is a matter of economy that the pump be chosen which will only raise the water the height that may be necessary at any particular time This will avoid the necessity of purchasing an engine and boiler of too great capacity In some plantations that have been visited it has been found that the effective lift was only one half of the actual lift which it will be readily seen is a great waste of fuel and plant capacity When open flumes are used, which are placed at the ordinary water level the water in flood times can be prevented from flowing back by means of flood gates placed in the flume

As may be noted above in the description of the pumping equipments of the various plantations the engines and boilers selected vary greatly They should however be chosen with due regard to first cost capacity reliability and economy of operation On some of the old sugar plantations the condemned boilers from the sugar houses are used and run at a low pressure In cases where the plan is only operated a few days in each year the cost of operation is not such a determining feature as when the plants are called on for regular work during each month of the year In this latter case it will probably pay to put more money into a better plant including automatic high-speed engines feed water heaters and other fuel saving devices In the former case simple slide valve engines with any suitable boiler are about all that will be required A point to be kept in mind is that these plants are usually run by more or less inexperienced labor and therefore complicated machinery should be avoided Economy in plant capacity should not however prevent the selection of machinery of sufficient size to take care in as short a time as possible of the probable run off from excessive storms as upon such drainage depends the plantation's success

Engineers and Journalists

Tools and Words

ENGINEERS and journalists are two very modern words embodying two very modern ideas yet they illustrate a contrast as old as humanity—the antithesis between tools and words technical arts and religion nature mastery and nature worship At all times however and now more than ever before representatives of each of these tendencies occasionally go over to the opposite camp

The invention of a new tool leads to discoveries of undreamed of things by thousands of the masters of world knowledge In the course of a century the magnifying glass is so greatly improved by a silk worker a glass blower and a mechanic that dozens of professors win fame by discoveries which they could not have made without the improved tool and which hundreds of other men could have made as well with it

On the other hand a profound thinker spins a web of living words that takes root and grows like a mycelium in a million brains and in time produces new tools as well as words

The priests of forgotten religions sought to influence the sun the lightning and the rain by pompous oratory but the tool the machine gradually replaced the word as a more efficient controller of the forces of nature Yet to this day the spoken or written word still exerts its mystic spell and sways the destinies of nations

Engineers and journalists form two of the youngest of professions The engineers move mountains and construct machines that vastly augment the power of man the journalists exert equally great influence in the political and social world yet both lack the prestige enjoyed by the older professions In political influence the engineers are far surpassed by the journalists The German Reichstag includes many journalists and writers but not a single engineer unless one is concealed in one of the factory directors who sit in the Reichstag Yet the engineer by his inventions and activities exerts an immense practical influence in political economy

Dr George Biedenkapp whose article in *Technische Monatshefte* is here freely summarized points out that neither the engineering nor the journalistic profession is a unit or recognizes a uniform standard of fitness An astonishingly large part in the progress of engineering has been played by untutored laymen Even so modern an invention as the steam engine includes among its developers the lawyer Porter and the merchant Corliss In engineering enterprises university graduates work beside and even under men who have graduated from the factory So in a great newspaper office a former typesetter may be on the chief of a highly educated staff This lawlessness is not only a symptom of youth but also a reason why engineers and journalists should view without prejudice many things that would create scandal in the old academically educated professions

The influence of the press itself a creation of the engineer will go on increasing and the engineers are extending their influence not merely by their technical achievements but by entering the ranks of journalism which already contain many men of technical training Many celebrated engineers and inventors have possessed great literary talent James Watt was an admirable narrator and so was the American inventor Worthington Max Eyth and Heinrich Seidel were poets as well as engineers Vauban the famous French military engineer was one of the earliest and most important writers on national economy The German inventors Riggenbach and Siemens and the American Porter the father of the quick running steam engine have left fascinating autobiographies Friedrich Harkort who erected one of the first German steam engine factories and built one of the first German steamships was an influential political writer

Furthermore the solution of the difficult problems of organization and economics which arise in industrial practice fit the industrial engineer for the position of social engineer Abbé not only improved the microscope but also endeavored to improve the conditions of factory life Freese and Oechelhaeuser wrote essays on the labor question The engineer's training offers many inducements to attempt to combine men as well as iron and wood into a perfect machine

Or was it by pure chance that Vauban wrote on the principles of just taxation that Eyth founded the German Agricultural Society that Harkort interested himself in the political and social weal of his fellow countrymen?

Language and thought have derived great benefit from technical discoveries If wheels, wagons, clocks, compasses springs and screws had never been invented we should be poorer by thousands of words and ideas Two centuries ago the French mathematician and philosopher Sophie Germain drew a plan of an exact science of politics in which the mutual actions and reactions of the elements of population were illustrated by the mechanical analogy of forces acting between material particles This enrichment of language and thought will be accelerated by the influx of men of mathematical and mechanical training into the journalistic profession Both journalism and politics will gain by this development, which is a necessary consequence of the overcrowded condition of the engineering profession Max Eyth sought a position in vain and Porter was twice forced from his post by commercial wisdom The dependence of the engineer upon the factory owner or contractor may be more galling than even that of the journalist upon the publisher The newspapers are continually devoting more attention to industrial and technical subjects, and no novel is complete without a description of an automobile or airship adventure The door of journalism therefore is opened widely to the engineer and thus the tool again becomes a power in the realm of the word

Depth of Water and Speed.

A curious result of the speed tests of fast-driven vessels is the discovery alleged to have been made in England, that the depth of water strongly influences the speed But it is not true as was until recently believed, that increase of depth is invariably attended by increase of speed

Experiments with the 'river class' of torpedo-boat destroyers have shown that at certain depths it takes the same power to give a speed of twenty knots as to give a speed of twenty two knots when the depth of water is forty five feet. On the other hand, there are points of minimum resistance For instance a speed of thirty-two knots in sixty feet of water can be obtained with less horse-power than in two hundred feet. The result, it is claimed in England, is even better at forty feet.

It seems to be established that in moderate depths the square of the speed in knots divided by ten gives the depth of water in feet where a sudden increase of resistance is felt. It all depends upon the influence of the bottom of the water on wave formation.

Solid Ceilings Between Iron Girders

A Summary of German Studies

By Robert Grimshaw

The German Association of Steel Manufacturers has prepared for the benefit of the public a work treating very thoroughly the subject of ceilings and girders and although its main object is to systematise plans for the manufacturers of iron beams and girders it will also be of great service to the makers of terra-cotta cement and other artificial blocks

In Germany the conditions are somewhat different from those in England and America but for all that a study of these will be of use to architects and builders in both these latter countries

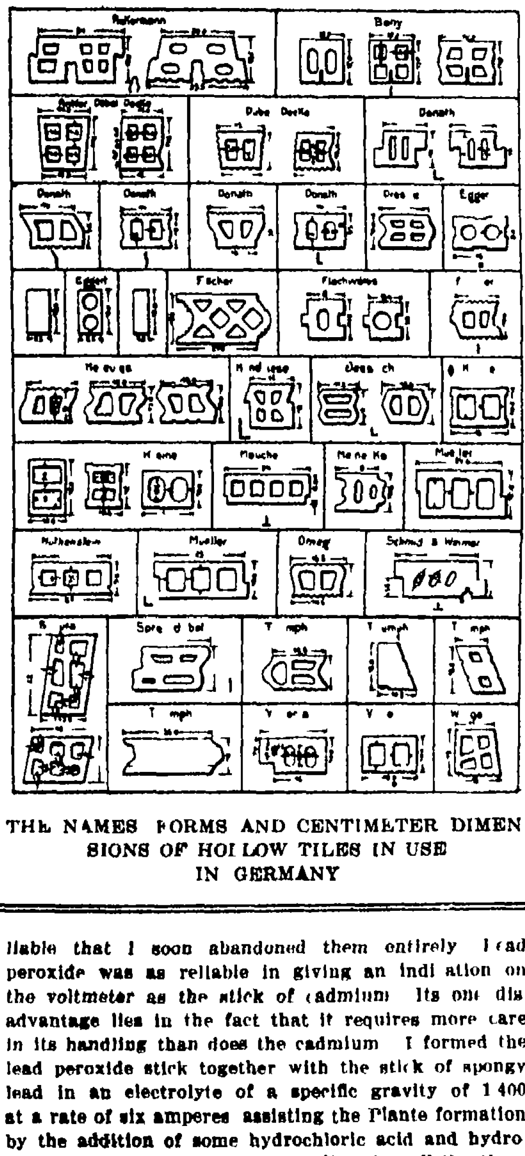
In Germany there are three general classes of ceilings—those with wooden joists those constructed entirely of concrete and those made of brick or tiles The first class was in the early days the only kind in use despite their insecurity from fire which it was vainly attempted to do away with by impregnating them with alkaline solutions In addition to this they transmit sound very readily which in these piano days is of importance in large cities Against this difficulty all sorts of filling have been tried but as one must reckon with the question of moisture many of these materials become rotten and unhealthful Further the wood itself when not properly seasoned and laid—and this is seldom done—gradually decays and once fungus steps in there is no salvation The trouble is brought from the forest and as the timber cutters and lumber merchants have no particular interest in saving the lumber from destruction once it has been sold this trouble will be likely to continue indefinitely The fungus which is only about 2 millimeters or 0 078 inch long passes through ordinary brick walls and infects one house from another

All these disadvantages are missing in the two other classes of ceilings

The concrete ceiling has its disadvantages also In the first place composing as it should a single built together structure it carries sound very readily and is also a good conductor of heat to and from the rooms covered This excludes it in many places from use in schools hospitals and private dwellings Concrete is also very heavy alkalies from the cement are apt to appear on the surface and the plastering does not adhere very well thereto In fact, in this last particular the Berlin Building Department allows its use only in such cases as do not require plastering of the under layer

The continuous nature of the concrete ceiling also renders difficult if not impossible any desired alteration And finally the laying of such ceilings requires a skilled personnel and it is often impracticable for the supervising architect to undertake any responsibility for the contractor because he cannot sufficiently well control the main conditions for a good concrete ceiling—namely the raw materials composing the mixture The concrete ceiling, however has its great advantages when it comes to the question of wide spans and heavy loads

The hollow tile ceiling between iron beams avoids all the above mentioned disadvantages In the first place as against the wooden ceiling it is absolutely fireproof—naturally if provision is made that the beams or girders shall not be exposed to the direct action of the flames Further because the tiles are hollow it does not conduct sound for the same reason it is a bad conductor of heat As it is composed of separate pieces which are not firmly bound together alterations therein may be made without difficulty or expense The ceiling plastering adheres well to the terra cotta there is no danger of shrinking and expansion such as cause cracks in buildings where wooden ceilings are used And finally it is easy to inspect and to control material and workmanship and no very skilled labor is necessary



THE NAMES FORMS AND CENTIMETER DIMENSIONS OF HOLLOW TILES IN USE IN GERMANY

The most simple kind of ceiling of its class is that in which there is a single arch between I beams (which by the way the Germans always call double T beams) of ordinary tiles porous bricks or light artificial slabs of ashes and plaster or the like Besides these there is a great number of more or less complicated fillings some of which have found great favor some very little or none Among those which have been introduced with success in Germany are the Forester Sekura and Klein types which are shown in the accompanying illustration in alphabetical order

As regards cost it is indisputable that in most cases the wooden ceiling is the cheapest A comparison of the cost of the concrete and the tile ceiling is difficult as here the cost of the raw materials comes more into consideration

The steel manufacturers have endeavored to aid builders in this particular and have come to the conclusions stated below

In the first place they have figured up an ordinary apartment house The cost per square meter (10 76 square feet) of all wooden ceiling and floor is 11 25 marks ($2 68) of reinforced concrete with wooden floor covering 13 2[illegible] marks ($3 16) hollow tile with wooden floor covering 12 95 marks ($3 08) For a one family house reinforced concrete with wooden floor covering 13 80 marks ($3 28) hollow tile with wooden floor covering 12 30 marks ($2 93) In this connection the manufacturers of tiles should look to their own interests by reducing the cost of their tiles and of laying also by preventing the wasteful use of mortar as for instance where it runs into the hollows of the tiles The practice of drawing paper tubes through the latter to prevent this is expensive Closed tiles such as were exhibited in the last Clay Industry Exhibition in Berlin will avoid this difficulty

The illustrations show about all the forms of hollow tiles which are in use in Germany the dimensions being given in centimeters (0 39 inch)

In cost figuring the mark may be taken as exactly 23 83 cents the square meter as 10 764 square feet

Some Interesting Storage Battery Plate Potentials

By Paul F Troi t

In experimenting to find a satisfactory substitute for the stick of metallic cadmium which is most commonly used in storage battery work when reading the charge on the separate plates I secured some very interesting results My purpose in conducting the experiments was to discover a means of taking complete battery readings where it was for any reason impossible to secure a stick of the comparatively rare cadmium This will be of especial importance to the man who must install peak load batteries in plants far from a large city

I confined my experiments to lead sticks free from any other metal because lead is always obtainable around a storage battery The sticks were taken in various states of oxidation and the following figures are representative of the readings obtained The readings were taken on cells containing Tate bifunctional accumulators with electrolyte of specific gravity 1 215

Some Interesting Storage Battery Plate Potentials

Cells	Volts	Cadmium +	Cadmium −	Lead Peroxide +	Lead Peroxide −	Spongy Lead +	Spongy Lead −	Unoxidised Lead +	Unoxidised Lead −
1	[illegible]	2 40	0 [illegible]	0 90	[illegible]	[illegible]	0 4[illegible]	2 06	0 [illegible]
2	2 70	2 40	0 [illegible]	0 90	2 60	[illegible]	0 46	1 90	0 50
3	2 60	[illegible]	0 [illegible]	0 [illegible]	2 60	2 26	0 54	1 98	0 56
4	2 45	2 34	0 07	0 [illegible]	2 34				
5	[illegible]	[illegible]	0 0[illegible]	0 [illegible]	[illegible]				
6	[illegible]	[illegible]	0 0[illegible]	0 91	[illegible]				
7	[illegible]	[illegible]	0 0[illegible]	0 91	[illegible]				
8	[illegible]	[illegible]	[illegible]	0 [illegible]	[illegible]				
9	2 64	[illegible]	0 [illegible]	0 61	[illegible]				
10	[illegible]	[illegible]	0 [illegible]	0 [illegible]	[illegible]				
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
12	2 41	[illegible]	[illegible]	[illegible]	[illegible]				
13	2 4[illegible]	[illegible]	0 0[illegible]	0 [illegible]	[illegible]				

As can be readily seen from the figures, spongy lead and unoxidised lead proved so uncertain and unreliable that I soon abandoned them entirely Lead peroxide was as reliable in giving an indication on the voltmeter as the stick of cadmium Its one disadvantage lies in the fact that it requires more care in its handling than does the cadmium I formed the lead peroxide stick together with the stick of spongy lead in an electrolyte of a specific gravity of 1 400 at a rate of six amperes assisting the Planté formation by the addition of some hydrochloric acid and hydrogen peroxide I charged in one direction all the time in spite of the fact that to reverse the direction of the current tends to deepen the layer of oxide I wanted the layer of oxide to be as compact as possible and thought that to reverse the current would result in softening it too much A deep layer of soft oxide might have increased the uncertainty of the readings

The lead peroxide stick showed some rather peculiar characteristics. For instance when it was taken out of the 1 400 specific gravity acid and used for a reading it caused the volt meter needle to waver up and down the scale in a very unsteady manner But it was all right after it had been washed in dilute acid It gave the best results after it had been washed in water and dried retaining its efficiency or capacity to give a steady indication to the volt meter needle for over an hour after being immersed in the electrolyte It is useless if kept for any length of time in distilled water Like the cadmium stick it must be inclosed in a piece of rubber hose with small holes cut in it to admit the electrolyte Most battery authorities say that the purpose of this rubber jacket is to keep the stick from touching the sides of the jar or the plates of the cell but my experiments lead me to the conclusion that its real effect is to minimise the electro-chemical action on the stick

It is interesting to account for the indications which these different substances give on the volt meter needle First it is well to understand the part which the stick of oxide plays when it is immersed in the electrolyte of a cell In every case the stick no matter what its composition plays the part of a negative plate when it is used in reading the charge on the positive plate and the part of a positive plate when reading the charge on the negative plate of the cell Cadmium sticks are always allowed to sulphate before they are used thus giving a stick of cadmium sulphate which acts when used in taking a reading as a completely discharged plate Lead peroxide on the other hand is in reality a fully charged positive plate and consequently it gives indications with the volt meter needle which are strongly the opposite of those given by the stick of cadmium sulphate but nevertheless they are always relatively the same in value For instance a given indication with a stick of cadmium sulphate will always be equivalent to a certain indication with a stick of lead peroxide From this it can be readily seen that it would only require a series of carefully taken readings to make a table showing the relative values of the indications given by the two sticks all through charge and discharge of a battery

Excavations at Delos—Excavation work is still continuing at Delos by archæologists connected with the French School of Athens with funds furnished by Duc de Loubat Among the late finds is a sanctuary devoted to an Egyptian cult It was built on the slope of the Inopos and dates from the third century B C according to Messrs Roussel and Picard who discovered it The latter archæologist also uncovered the ground around the Sacred Lake and great stadium which was situated at the northeast end of the lake Many inscriptions were found on this spot He also explored the Roman walls of Delos these being built by Trarius in 70 B C

A Gravity Service for Handling Bricks

A Remarkable Labor-Saving Device

By Frank C Perkins

Many and varied are the labor saving devices scattered through all departments of the industry and commerce of the present day The desired result may be obtained sometimes merely through the assistance rendered to the hand by some specially designed tool or by a particularly favorable arrangement of parts Often however the contrivance employed does more than this it supplies the power which is required for

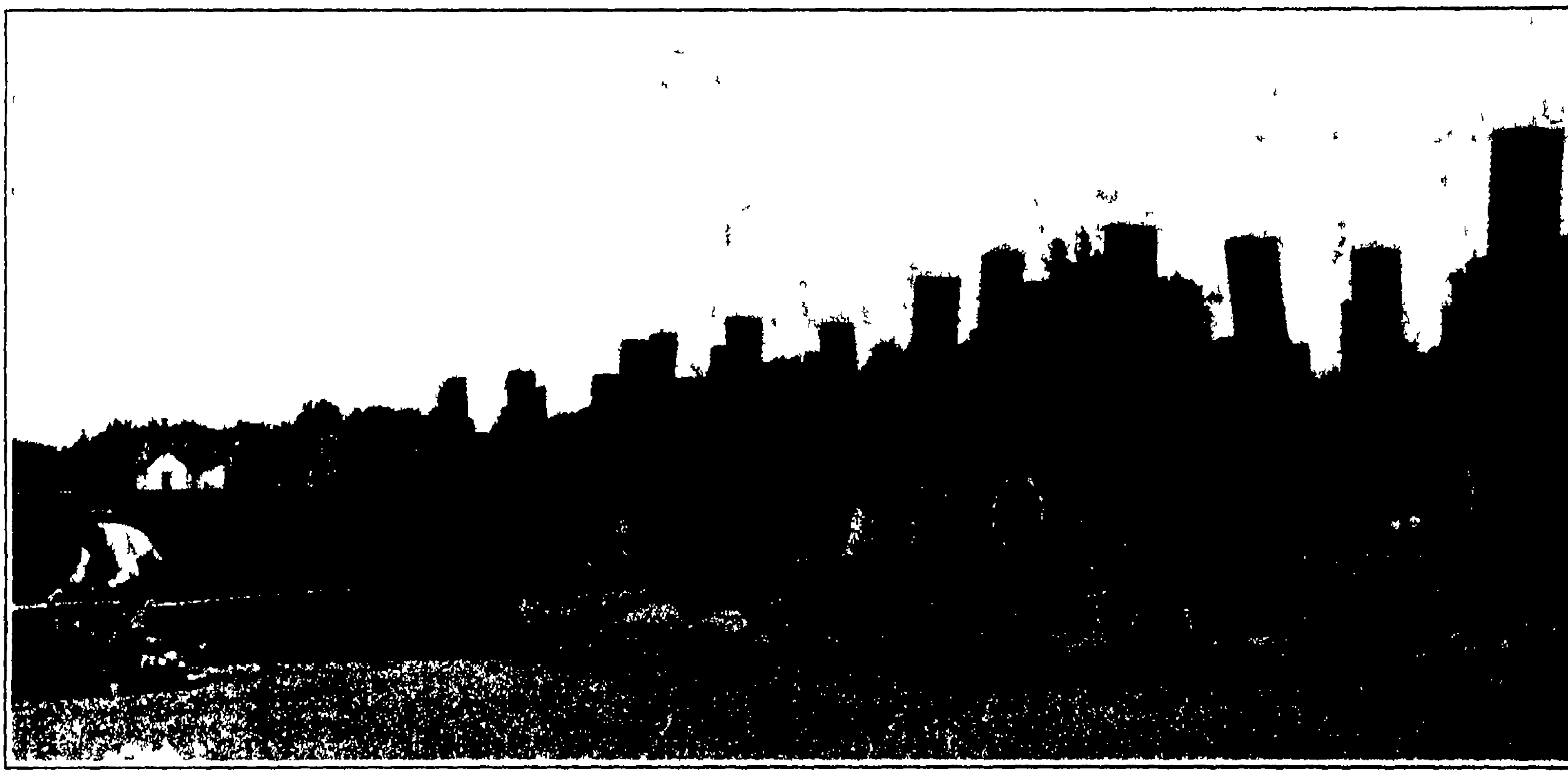


FIG 1—GRAVITY BRICK CONVEYOR AT THE WORKS OF THE LAWRENCE VITRIFIED BRICK AND TILE COMPANY KANSAS

FIG 4—LOADING BRICK UPON GONDOLA CAR

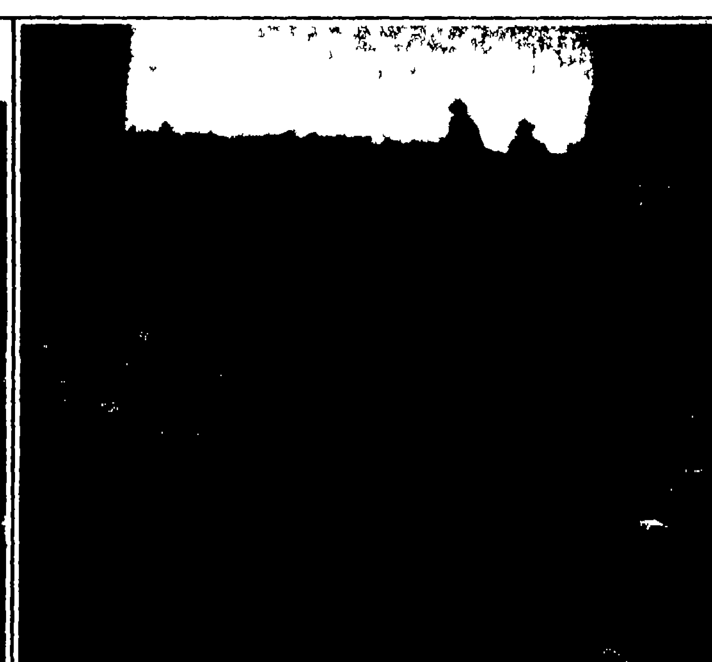


FIG 5—KILN END OF CONVEYOR

GRAVITY SERVICE FOR HANDLING BRICKS

the work incident to the operation The source of power is on the whole immaterial so long as it satisfies the ordinary requirements of convenience and cheapness A source of energy which in certain cases eminently fulfills these conditions is the gravitational work which all bodies are ready at all times and in all places to perform as soon as they are given an opportunity to travel downhill And in point of fact gravity feed is resorted to upon innumerable occasions in technical work A special instance of this kind is depicted in our illustrations which display several aspects of a gravity brick conveyer As will be seen by referring to our illustration and for detail especially to Fig 2 the conveyer consists simply of a roadway or bed whose bottom is formed of a series of transverse rollers, upon which the bricks are laid, and over the gently downward slope of which they proceed to their destination whether this be the brick stack in the factory in which they are made as in Fig 1 or the car (Fig 4) in which they are to be shipped or what not.

Some of the details of construction are exhibited in Fig 2 It will be seen that the rollers are mounted upon ball bearings The main portion of these rollers are cylindrical in shape but at the curves in the line they are made conical so as to give the requisite inward tilt to the moving material

Ten years ago little thought had been given to the great possibilities of gravity conveyers for transporting merchandise from point to point in and about factory plants To-day the system is a recognized element in factory and warehouse economy Its development has been rapid and scientific Practical men in all lines of manufacturing recognized its value the moment it was brought to their attention perceiving that its chief merits lay in economy of labor and time the two great essentials in profitable manufacturing The use of the gravity system often reduces the loading expense one-half over older methods besides making it possible to load more cars in a day than under former conditions.

Progress in Locomotive Design

The most remarkable step in the progress of steam locomotive design that has been made for many years is without doubt says the *London Times* the new method of arranging the cylinders which has just been introduced by the Nord Railway in France This method which consists in placing the inside cylinders one in front of the other instead of side by side according to the common plan adhered to until now since the earliest days of inside-cylinder locomotives, postpones to some undetermined period the limitation of the diameter of inside cylinders.

For many years past, writers have urged that finality in constructional limits for powerful locomotives would shortly be attained by reason of the impossibility of introducing cylinders of sufficient size for the power required within such limited loading gages as those of England and France It was in 1899 that

M. Polonceau, of the Paris-Orleans Railway affirmed that the French gage did not permit the building of two-cylinder compound locomotives of economical design, for the reason that the low pressure cylinder could not be made large enough to allow of an economical second expansion of the steam and the French railways thereafter adopted the multiple-cylinder compound system for rather small locomotives. Now, over twenty years later in building the largest and most powerful railway engines yet constructed on this side of the Atlantic the Nord Railway has found that even for four-cylinder engines as hitherto built all over the world with side by side cylinders the limits to the dimensions of low pressure cylinders have been reached and to overcome this difficulty the cylinders for its new Baltic type locomotives have been placed zig zag one just in front of the other. This arrangement enables cylinders to be made nearly half as large again as compared with the ordinary side-by side arrangement.

ADVANTAGES OF THE NORD SYSTEM

The new method adopted for the Nord Railway by M. Asselin the new chief engineer of motive power is of great interest to every main line locomotive engineer not so much for the ingenuity of the design with one piston rod working through the wall of the adjoining cylinder barrel as for the key it presents for the solution of the many problems in construction which have arisen as a consequence of the great increase in the size of locomotives and which involve notably the dimensions of the webs in cranked axles the width of the connecting rod big ends, and the length of the journals.

With the Nord system the centers of the two inside cylinders are brought very close together so allowing of considerable amplification of parts in the machinery which until now have been gradually thinned down to accommodate the lessened space available between the connecting rods and the frames in engines fitted with very large inside cylinders, such as have become common with the use of expanded or superheated steam as also for the low steam pressure expansion in compound locomotives. A great increase in the strength of turning parts now becomes possible and this considering the danger attending the failure of a cranked axle adds to the value of the immense power augmentation possible in the cylinders of either two-cylinder or four-cylinder engines.

The new arrangement is of utility for any class of steam locomotive but it is of greatest value in low pressure engines requiring large cylinders. At the present time there is a tendency to return to low steam pressures in order to economize in boiler repairs. To utilize these low pressures the piston areas have been increased correspondingly for given the possibility of using very large pistons the return to pressures of 120 pounds even with saturated steam becomes quite practicable and examples of very low steam pressures in saturated steam compound and simple engines are now to be found in current European practice.

ECONOMY OF LARGE CYLINDER RATIOS

The chief value of the Nord system for compound engines lies in the fact that it permits the use of low pressure cylinders having a rational volume three times greater than the high pressure cylinders. This ratio of volumes 1 3 has been found in practice to increase the efficiency of the compound engine per unit weight of volume of steam consumed by at least 35 per cent with respect to single expansion of the same quality of steam in a similar type of simple engine that is each pound or cubic volume of steam develops 35 per cent more horse-power averaged for a period of several years consecutive working than the same weight or volume of steam expanded once only in a similar type of locomotive working the same fast express train services. This economy however becomes less and less as the difference between the volumes of the two expansions decreases. With small low pressure cylinders of only twice the volume of the high pressure cylinders it is found that the increase of efficiency averages only about 5 per cent while with a low pressure cylinder volume of 2½ times the high pressure volume the increase of efficiency is about 18 to 20 per cent. This experience has been common to practically all countries where two stage expansion is used in locomotives and it shows the great value of large ratios of cylinder volumes if the construction gage permits of them.

LARGER CYLINDERS POSSIBLE

Hitherto in both England and France the realization of the great economy possible by two stage expansion has been restricted by the limits of the loading gage but the new stepped cylinder arrangement of the Nord Railway entirely removes this disability especially if it is combined with certain differences in the frame plates as employed for several years in France and Belgium—that is perforations in the frames allowing the inside cylinder to project through to the outside by a few inches and so considerably increasing their volume.

The new Baltic type engines of the Nord have straight unperforated frames and additional volume has been gained by lengthening the cylinders according to the practice of Bavarian builders. There are certain objections to this practice of lengthening the stroke and an alternative arrangement common in Italy consists in mounting the inside cylinders clear above the frames so that they may project over the edges of the frames without interfering with the outside cylinders placed on the same transverse level

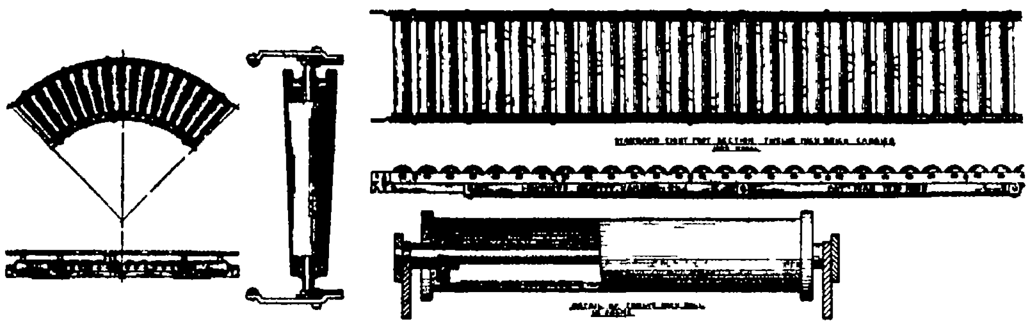


FIG. 2.—DETAILS OF CONSTRUCTION OF BRICK CARRIER SHOWING BALL BEARINGS AND THE CONICAL ROLLERS AT A CURVE

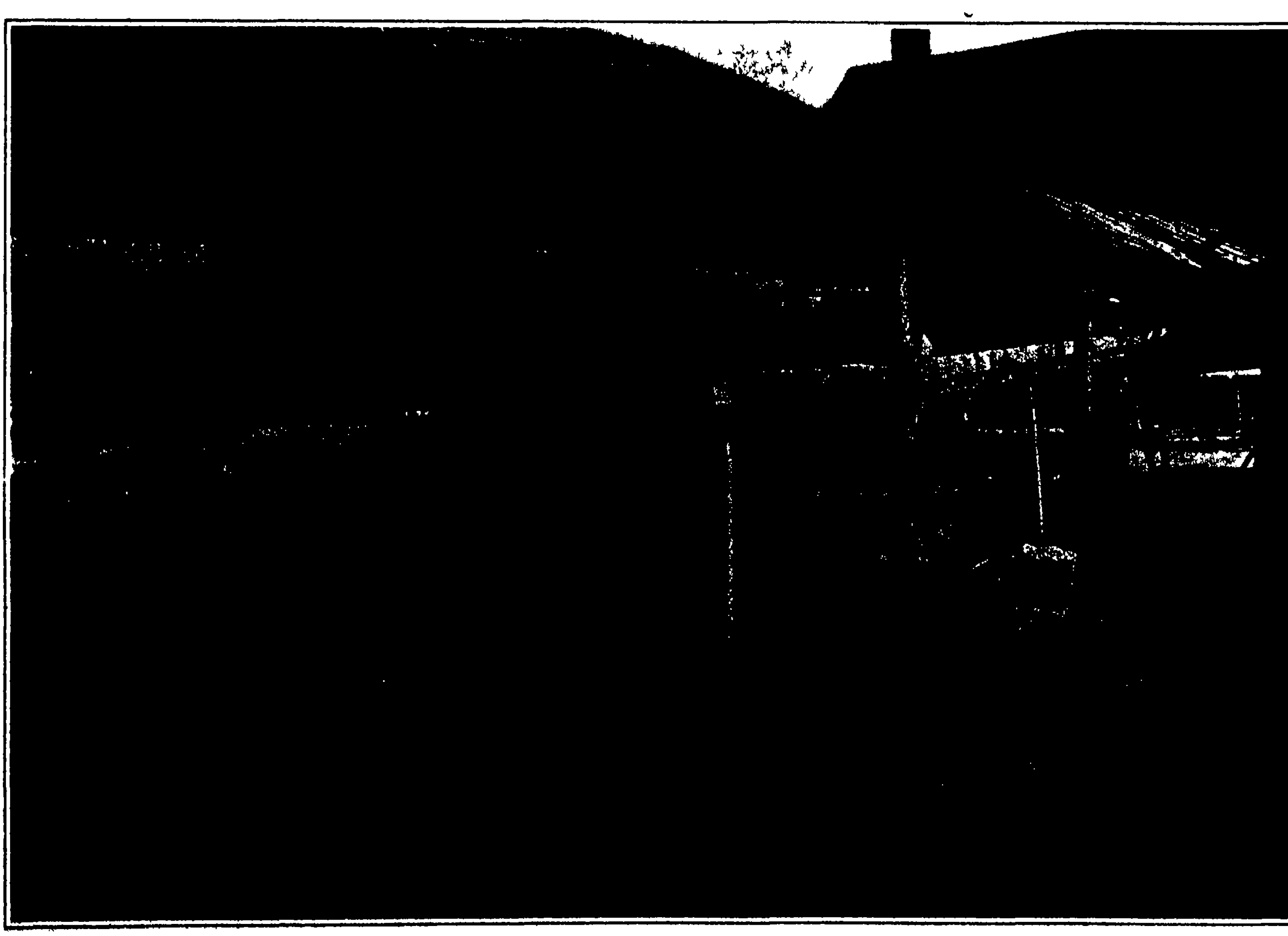


FIG. 3.—FROM KILN TO CAR BY GRAVITY

GRAVITY SERVICE FOR HANDLING BRICKS

With the Nord stepped cylinders and the Italian plate frames it becomes quite practicable to build two-cylinder compound locomotives having one 23 inch and one 40 inch cylinder both set very closely and compactly together inside the frames and able to develop the same power at full speeds as much more complicated four cylinder non compound locomotives with four 16-inch cylinders With an equal weight of steam from the boiler in each case the one 23 inch cylinder working single expansion develops the same power as two 16 inch cylinders In compound expansion the one 23 inch cylinder develops less power on a given steam admission for the reason that, with cylinders of 1 3 ratio its power capacity is reduced by the back pressure about 15 per cent but this exhaust steam producing the back pressure develops on the low pressure piston a power which is equivalent to the total effective power developed in the high pressure cylinder That is, if 500 horse-power is developed by boiler steam in the high-pressure cylinder, about 500 horse-power is developed by the high-pressure exhaust steam in the large cylinders and the larger the low pressure cylinders are made the less is the loss by the back pressure in the small cylinders and the greater is the total load on the large pistons With a loss of 15 per cent in the area of the high-pressure cylinder indicator diagram the net economy by the two-stage operation is 50 per cent—15 per cent = 35 per cent.

These figures are confirmed by years of practical experience on railways using large cylinder ratios where there is no restriction to the size of the low pressure cylinders. In general with such ratios one-third less steam is required for a given horse-power or one-third more power is produced on a given fuel or steam consumption But this result is dependent on high cylinder ratios, such as are now rendered feasible for the most restricted main-line loading gages of Europe. The importance of the saving that could thus be effected is apparent from the fact that with say, 100 compound locomotives the coal consumed would be worth £65 000 annually, whereas with the same number of simple-expansion engines, working with the same pressure and temperature of steam in the same train services it would be worth £100 000 Further with the Nord system it becomes practicable to develop the two-cylinder type with its advantages of simplicity as compared with the far more complicated and expensive four-cylinder non-compound engine In all details except in the boiler the locomotive designers of all countries are seeking for simplicity and the Nord arrangement especially appeals to those who would avoid four-cylinder engines of any type

Salving the German Submarine Boat "U 3"

An Authoritative Account

On January 17th 1911 the German submarine boat U 3 was sunk in the harbor of Kiel (Fig 1) by the imperfect closure of the after ventilation pipe The depth of water was about 40 feet and the stern of the vessel penetrated several yards in the soft clay bottom As the boat sank her irregular movements were observed by the submarine U 1 which hastened to the spot launched a folding boat to pick up the telephone buoy of the U 3 and then notified a warship which transmitted the news to the Kiel dock yard so promptly that two steamers and a crane were dispatched 28 minutes after the vessel sank Meanwhile the imprisoned men had informed the folding boat by telephone that the after part of the U 3 was full of water Communication then ceased

The disaster was observed also by the lookout stationed on the Kaiser Wilhelm Canal and by the canal pilot steamer which soon arrived on the scene and endeavored with the aid of a tug to tow to shore the foundered submarine the bow of which had risen to the surface The attempt failed as the stern of the submarine was held down by some 100 tons of water The crane arrived about an hour after the disaster and with the aid of divers attached to the canal service preparations to raise the sunken boat were commenced

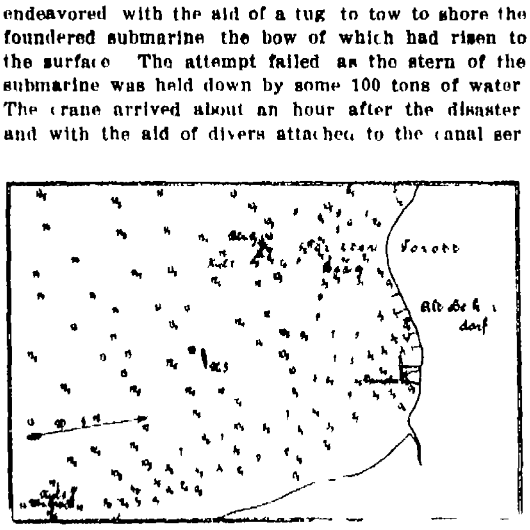


Fig 1 Part of the Harbor of Kiel Showing Position of the Foundered Submarine Boat U 3

(The arrow and its inscription show the direction of the wind and its velocity in meters per second The other figures indicate depths of water in meters.)

It appears probable that the extent of the leakage was not at first, fully appreciated by the crew of the U 3 as the partly opened valve was invisible and inaccessible and the mouth of the ventilation pipe through which the water entered the hull was covered and concealed by the motor Hence the inrush of water could only be heard and the water was not seen until it had reached the floor of the engine room It was then too late to take effective measures The boat sank stern foremost and its position aggravated the evil by increasing the hydrostatic pressure at the leak and in other ways

The tanks which had been so nearly filled in preparation for diving that only one ton of buoyancy remained before the accident were emptied by pumping and by compressed air Meanwhile the compartment bulkheads were closed the emergency weights dropped and the telephone and lifting buoys set afloat An attempt was then made to pump out the engine room bilge but the pump would not "draw" owing to the position of the vessel The water soon short circuited some of the accumulators producing results far more serious than the stoppage of the useless pump The sudden discharge so heated the forward cells which were not yet submerged that several plates became red hot and some of the hard rubber parts took fire. The heated cells evolved suffocating sulphurous and acid fumes which caused the commander to order a retreat to the forward or torpedo compartment The commander with two other officers remained in the middle compartment and turret and continued the work of emptying the forward tank by means of compressed air until the bow of the boat rose 20 inches above the surface of the water The 28 men imprisoned in the torpedo compartment owe their lives to this wise and heroic action of Lieut Commander Fischer and to the stanchness of the collision bulkhead which separated them from the turret compartment

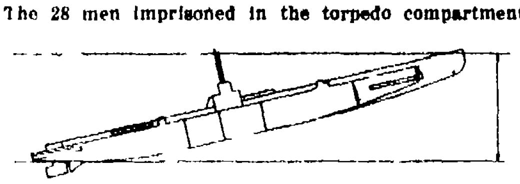


Fig 2

At 11 30 A M 65 minutes after the accident occurred an inspector of the torpedo service arrived on the scene and found the sunken vessel in the position described above with the prow and the periscope emerging slightly from the water and the stern embedded in the clay bottom (Fig 2) Assuming that the crew had taken refuge in the forward compartment he attempted their rescue by the method illustrated in Fig 3 The floating crane (represented by the large rectangle) was anchored close to the weather side of the "U 3 and made fast by a chain passed around the submarine with the aid of divers (The small rectangle represents the divers boat moored on the lee side of the U 3) Meanwhile other divers were working to attach the main tackle of the crane to the forward lifting hook of the U 3 The latter task was not accomplished until nearly 3 P M Soon after that hour the bow of the submarine was slowly raised by hauling on the main tackle and occasionally tightening the chain stirrup until the forehatch was just awash (Fig 4) The operation was then stopped in order to communicate with the imprisoned men by tapping according to the Morse code, on the exposed part of the hull. The first attempts were frustrated by irregular knocking from the inside It was afterwards learned that the imprisoned men were fastening the bulkhead doors, which opened inward (forward) and consequently did not entirely exclude the poisonous gases which were forced upward from the central compartment by the pressure of the water After this work had been finished communication in Morse signals was established, and the imprisoned men reported All is well ' When they learned that the bow was out of water they announced their intention of opening the torpedo launching tubes Boats provided with sounding lines were then stationed beneath the mouths of the torpedo tubes and the bow of the U 3 was lowered until these mouths nearly touched the water Meanwhile the imprisoned men working by the light of a single pocket lantern had succeeded in opening the starboard torpedo tube At 4 30 P M the first man was drawn out by means of the sounding line The work of rescue proceeded smoothly until an increased influx of poisonous gases caused the man who was being drawn out to let go the line and fall back unconscious A call was then made for volunteers to go down and attach the imprisoned men to the line In this way several men were rescued by a boatswain s mate who was finally drawn out unconscious Two officers, carrying an electric lamp connected with a cable and a compressed air tube from the D 5 which was moored beside the crane (Fig 3) then went down and rescued the remaining men most of whom were unconscious The work of rescue was completed at 5 20 P M The starboard torpedo tube was necessarily left open

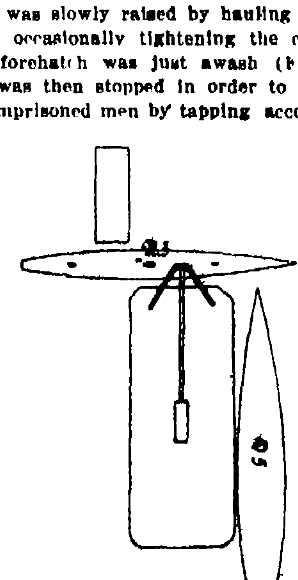


Fig 3

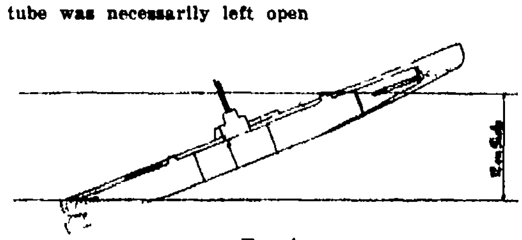


Fig 4

Nearly one-third of the men rescued from the forward compartment were unconscious They were taken to the lower deck of the crane float and revived by oxygen inhalations and other treatment In less than two hours they were in condition to be removed to a hospital where most of them fully recovered in a few days

During the work of rescue preparations were made to raise the stern of the U 3 in order to rescue the captain and the other two officers who were imprisoned in the turret For this purpose a stout cable was attached by divers to the after lifting hook of the sunken boat At the same time efforts were made to put into service the emergency ventilating apparatus but the attempt failed because as was learned aferward the valves in the middle compartment were closed

Meanwhile imperfect communication with the imprisoned officers had been established by means of a board on which questions were written and which was held in front of the periscope The prisoners answered 'Yes' and "No' by turning the periscope to left and right This conversation continued from 3 to 5 P. M.

The hawser which had been fastened to the after part of the "U 3" was attached to a second and more powerful crane (Fig. 5) At 5 30 P M., ten minutes after the last man had left the torpedo tube, this second crane began hauling with great caution, pausing at intervals to give the stern of the "U 3" time to work out of the soft clay in which it was imbedded, while the forward crane exerted a steady pull of about 100 tons. When the stern of the "U 3" had thus been raised about 4 feet, the hawser parted and the boat sank back. The divers then substituted two new hawsers for the broken one, and the work of raising the vessel was resumed at 6 30 P. M., but the operation was soon stopped and the fate of the imprisoned

officers sealed by the breaking of a post of the after crane.

These two failures proved that the "U 3" could not be raised in this way. Nothing remained but to raise the sunken boat by means of the salvage ship Vulcan, a sure but tedious method, which practically excluded all hope of saving the lives of the three heroic officers.

The "Vulcan" was used, in connection with the submarines "U 3" and "U 1," as a school of submarine navigation, the pupils and the crews of the submarines being quartered on the mother ship.

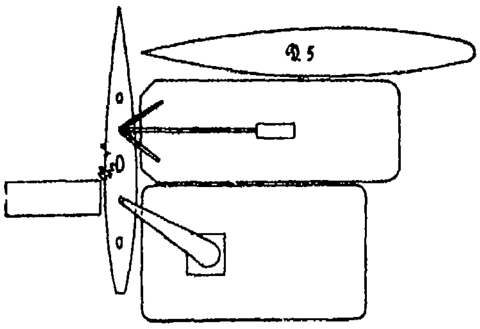


Fig. 5

There was good reason for her previous inaction and her absence at the moment of the disaster which need not be explained here.

On the morning when the accident occurred the Vulcan was in dock at Kiel, and for this reason the submarines were practising in Kiel harbor, one always remaining afloat when the other dived. The Vulcan arrived on the scene at 1.30 P. M., but remained idle because it would have taken her at least six hours to raise the U 3, which even in its lowest position (Fig. 6) was too high to allow the Vulcan to employ her usual and most expeditious method of anchoring at bow and stern to windward of the sunken vessel and drifting over it.

After the crane broke the best method of employing the Vulcan was discussed and every detail was decided while the divers detached the hawsers and the sling from the U 3. The disabled crane was removed and the other crane was drawn back about 40 yards. The scene was brightly illuminated by the searchlights of two vessels. The U 3 now lay in the position shown in Fig. 6, entirely under water, though the top of the periscope could be seen just beneath the surface. The positions of the periscope and the bow were marked by small boats.

The difficult work of the divers was not completed until 8.55 P. M. Then the Vulcan was brought alongside the remaining crane and attached by bow and stern lines (Fig. 7). With the aid of these lines the Vulcan was swung around through a right angle so that she lay parallel to the U 3, and was held in this position by the starboard stern anchor which had been dropped midway (Fig. 7).

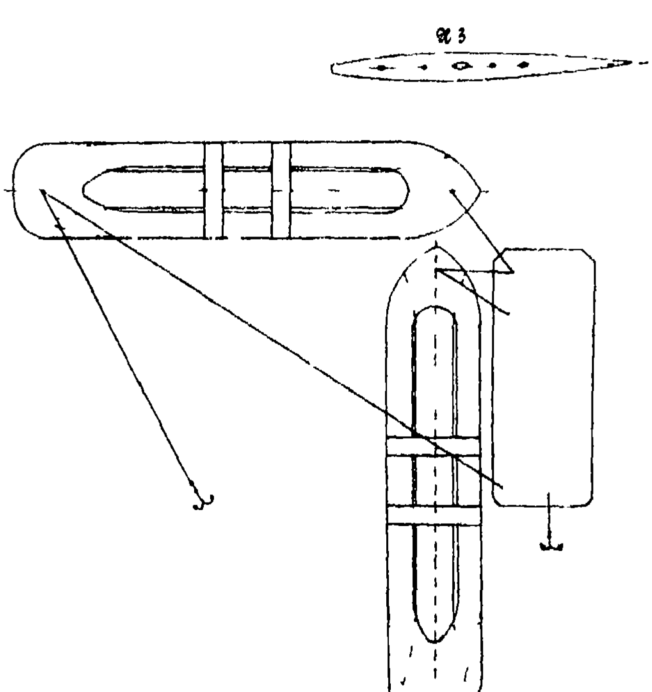


Fig. 7

The moorings of the "Vulcan" and the crane were then cautiously relaxed and the two vessels, retaining their relative positions, were allowed to drift toward the "U 3," until the bow of the double-hulled "Vulcan" was directly over the stern of the sunken vessel and immediately behind the periscope (Fig. 8). Now came the delicate task of moving the "Vulcan" forward with one of its twin hulls on each side of the "U 3," without breaking the periscope and thus flooding the turret and central compartment. This maneuver, the difficulty of which was increased by a strong side wind, was successfully accomplished with the aid of the port stern anchor and several small steamers which served as bow anchors and tugs.

The Vulcan was thus brought into the position shown in Fig. 9, with her hoisting tackle directly over the lifting hooks of the U 3. The tackle was attached by divers (a task which occupied two hours) and the work of hoisting began at 4 A. M. The turret appeared above water at 4.35, and was opened ten minutes later. The abnormal pressure in the confined space caused an outrush of foul air which smelled strongly of chlorine. The turret was ventilated with compressed air, a lamp attached to an electric cable was lowered, and two officers entered. They found their three ill-fated comrades dead at their posts in peaceful attitudes which appeared to exclude all possibility of a death struggle. Although they had evidently been dead for hours, two hours were employed in fruitless attempts at resuscitation.

After the bodies had been removed the turret was closed and the U 3 was securely fastened to the Vulcan, brought into the inner harbor and docked.—Condensed from *Marine Rundschau*.

Improvements in Street-car Wheels

Before the Alabama Light and Traction Association Mr. S. M. Coffin recently read a paper on *improvements in street-car wheels*, in which he reviewed the developments in weight, size and shape of car wheels and detailed the experience with steel wheels of the Mobile Light and Traction Company. The company have two makes of wheels which vary in weight from 500 pounds to 645 pounds per wheel, with a rim thickness of 2½ inches to 3 inches and web thickness ¾ inch to 1¾ inches, with 2¼-inch tread or 3 11/16-

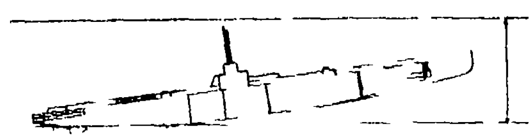


Fig. 6

inch width of rim, and also varying considerably in hardness. Two pairs tried under a single-truck car have shown more difference in wear than any others. For instance, one pair ran but 21.8 6 miles with a wear of 0.0183 inch per 1,000 miles and had to be turned. This took off 0.0272 inch per 1,000 miles or about 50 per cent more than the wear. They then ran 19,400 miles with 0.0211 inch per 1,000 miles. They were then taken out and the one which had developed a thick flange was ground 0.13 inch, making it 0.05 inch smaller than its mate, which was not touched. After this the wheels made 21,180 miles when they had to be reground. The flanges were now very thin, but they were allowed to run again as an experiment in flange wear. An additional wear of 8,000 miles was obtained before another turning. During all this time the other pair of wheels had never been out and their flanges were wearing uniformly, although they were getting thin by this time. They were turned after running 93,482 miles with a wear of 0.0105 inch per 1,000 miles. The stock removed in turning was 1.3 inch (0.0141 inch per 1,000 miles) or a total for wear and tool of 0.0173 inch per 1,000 miles. A large number of wheels have run 60,000 to 90,000 miles without removal with the wear as low as 0.006 inch per 1,000 miles and with an average for ten pairs selected at random of 0.0109 inch service wear and total wear and tool of 0.0122 inch per 1,000 miles. However, by deducting the first two pairs of wheels mentioned an average of 57,888 miles

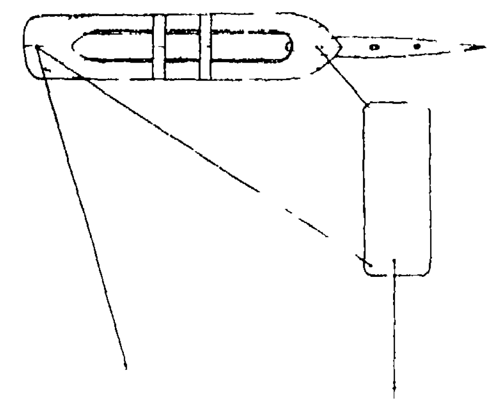


Fig. 8

is obtained with an average wear of 0.00992 inch and wear and tool of 0.0098 inch per 1,000 miles. This result, however, was attained by grinding instead of turning.

The Repin Refrigerating Process

In the ordinary type of chemical or affinity refrigerating apparatus the reduction of temperature is produced by the rapid evaporation of liquefied ammonia. The gaseous ammonia is recovered by means of its affinity for water, which absorbs it in great quantities. By heating the solution thus obtained the ammonia is expelled into a cooled receiver, where it is liquefied by its own pressure. This apparatus possesses a serious defect which has gradually driven it out of use. The ammonia expelled from the solution carries with it about 25 per cent of water.

According to *La Nature* Dr. Repin has devised a *chemical refrigerating process which is free from this objection*. The refrigerant is sulphur dioxide, which is easily liquefied and absorbs much heat in its evaporation. The absorbent is camphor, which takes up 30 per cent of sulphur dioxide, forming a very stable solution of low vapor tension, which when heated evolves all of its sulphur dioxide in gaseous form. The heated mixture, however, foams excessively and the camphor is left in the melted form in which it is unsuitable for further use as an absorbent.

Dr. Repin has remedied these defects by mixing with the camphor 20 per cent of naphthol. The only liquid thus obtained retains all the power of the camphor to absorb sulphur dioxide, which it disengages completely at a temperature below 212 deg. F. The pressure of the gas during the distillation does not exceed 5 or 6 atmospheres and a temperature of 17½ deg. F. can be obtained. This method appears especially well adapted to economical refrigeration on a small scale, in laboratories and elsewhere.

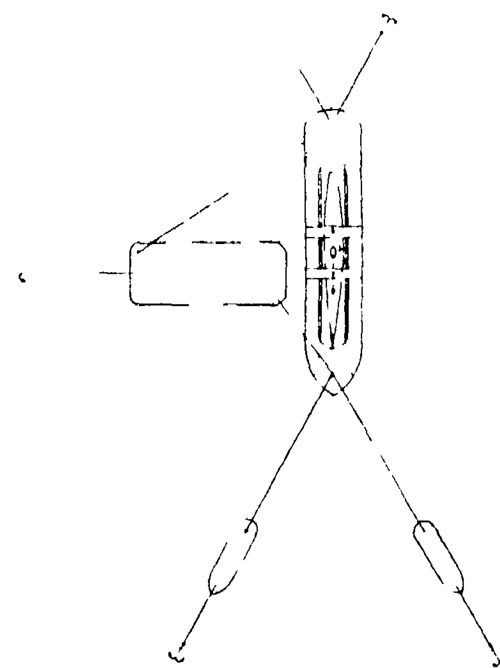


Fig. 9

The Light of Living Animals

The Structure of Photogenic Organs

By F Alexander McDermott, Washington, D. C

THE power of producing light in living tissues—the photogenic function—is a property widely distributed in the animal and vegetable kingdoms especially in marine organisms In general the light produced by the various living photogenic forms is very similar in character being in most cases confined to those radiations which have the highest illuminating effects, with the lowest actinic and thermal effects The maximum brightness of the light given out by such organisms is usually at or about wave length 0 57 μ[1] in the yellow green where the light has an illuminating efficiency of practically 100 per cent Moreover the production of light in all cases where definite studies have been made appears to be the result of the oxidation in the presence of water of some product of the life processes of the creature But in spite of these general similarities there are wide differences between different forms in the apparatus by means of which this production of light is effected Many of the lower forms possess no definite organs for the function—the emission of light like their sensitiveness to it being a property of the cell as a whole Among the higher forms also we find some in which the light is produced within special cellular masses having no very definite structure Both of these cases may be classed as simple intracellular photogenicity Still higher in the scale we find those forms in which the light is produced within definite organs of more or less complicated structure—usually glandular—and in these the production may be either intracellular and intraglandular or extracellular and intraglandular In still other forms the glands and secretions may both be luminous (intra and extraglandular) and in still others the secretion of a non luminous gland may be luminous when the photogenicity becomes entirely extraglandular An attempt will be made here to describe some of these peculiar variations of the photogenic function and to give what is known of the structures used in its production

Probably the simplest forms possessing the photogenic power are the luminous bacteria of which there are a large number of species known On account of their extremely small size no definite organs for the production of light have been observed but the luminosity appears to result from the oxidation of some product of the metabolism of the cell and usually necessitates the presence of some mineral salt—notably sodium chloride for its manifestation Higher vegetable forms—fungi mycelia algæ etc—do exist however which do not appear to require the presence of mineral salts for the development of light at least not in the same amount as the bacteria require sodium chloride or some similar compound and which yet give a light not unlike that of the less highly organized forms In these however no special photogenic organs have been shown to exist and it seems not improbable that in the bacteria fungi and other luminous vegetable forms the photogenicity is a property of the individual cells inherent in them and consisting of the oxidation of some portion of the cell constituents

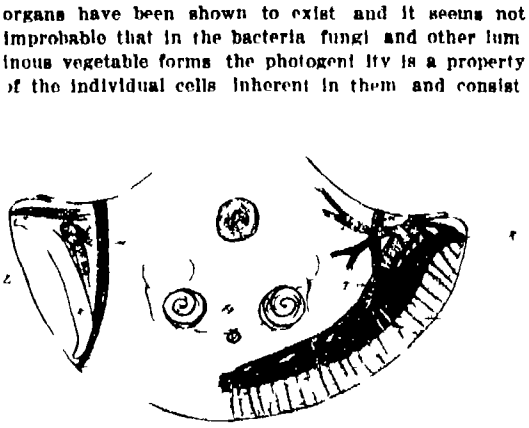


Fig 1 Transverse Section of *Photinus Pyralis* (Diagrammatic)

The right hand half shows the arrangement and distribution of the tracheæ while the left hand half shows the modification of the luminous tissue at the point of attachment of the breathing muscles
C testes I intestine L true photogenic tissue R reflecting layer S spiracle or stigmatum Sp spiral organs (function uncertain) T main tracheæ to photogenic organ Tb main respiratory tracheæ M muscle fibers

Among those classes which constitute the lowest forms of organized matter it becomes somewhat difficult to distinguish between those which should be classed as vegetables and those which belong to the animal kingdom Many of the bacteria known to produce light are marine in origin, and with them may be grouped the numerous simple marine animal forms which also possess this power *Noctiluca miliaris* the *Pyrocystæ* and many other animal forms of low organization possess no definite organs for the photogenic function Under the microscope however, the light in these forms is seen to proceed from a multitude of tiny points and it may sometime be shown that these points of light are true luminous organs having some more or less complex structure

The higher we go in the scale of animal life the more specialized and complex become the organs for the production of light. For instance Pyrosoma, a Tunicate ascidian shows the restriction of the phenomenon to certain portions of its constituent animalcules and while but little of the structure has as yet been made out these portions are doubtless definite photogenic organs Panceri has estimated that in a Pyrosoma eight centimeters long there are 6 400 of these liminous organs two to each of the constituent animacules In the molluscs insects crustaceans myriapods cephalopods and fishes the photogenic organs show definite and characteristic structures In all of these groups there are one or more species known which have complex organs for the production of light In the different types and species however the structures of the photogenic organs vary considerably Those of the sea living organisms for instance as might be expected differ widely from those of the air breathing forms

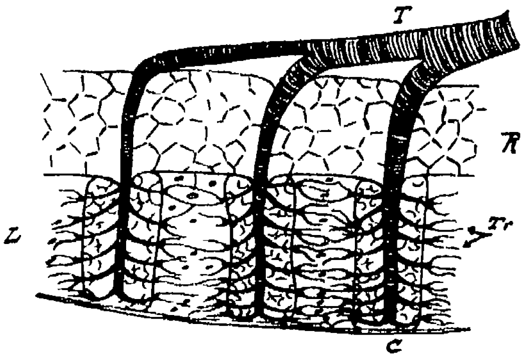


Fig 2a —Vertical Section of Photogenic Organ Showing Trachea T With Three Branches Passing Through the Reflecting Layer R and the Photogenic Layer L Surrounded by the Cylinders C and Branching into Tracheoles Tr

The luminous forms most familiar to the majority of us are the Lampyridæ—the fireflies lightning bugs glow worms etc —and upon these the bulk of the work on the structure of photogenic organs has been done It is common knowledge that if a firefly is crushed and the luminous tissue exposed to the air it glows this suggests that the phenomenon is dependent on the presence of air or some of the constituents thereof This view is borne out by the structure of the photogenic organs of these insects Perhaps a dozen different species of the Lampyridæ have been submitted to examination as to the structure of these organs and in general the structures have been found to be the same slight differences mainly in the finer structures have been described and illustrated but for all practical purposes the photogenic organs of the different species of this family of insects may be regarded as substantially the same Fig 1 represents a diagrammatic cross-section through a Lampyrid at about the middle of the fifth abdominal segment the particular species from which this is taken is *Photinus pyralis* one of the commonest and most widely distributed varieties in the United States

In this drawing *C* is one of the testes *I* is the intestine *L* is the photogenic tissue proper *R* is the reflecting layer *S* is the spiracles or stigmatum *Sp* are spiral organs connected with the reproductive systems *T* are the main tracheæ and their branches leading to the photogenic-organ *Tb* are the tracheæ leading to the other organs—the general respiratory system of the insect—and *M* the breathing muscles The luminous organ consists of two layers, *R* and *L* *R* is primarily a reflector and consists mainly of a layer of guanine or ammonium urate or both, contained in polygonal cells *L* consists of cells of irregular size and shape and constitutes the true photogenic layer, in which the biologic oxidation and its consequent light production take place The main tracheæ begin at the spiracles, just below which they divide from the breathing tracheæ, and continue downward and inward towards the middle of the ventral side of the abdominal cavity, continually throwing off branches which again subdivide, and so the subdivision goes on to the fine tracheæ which plunge through the photogenic organ The larger tracheæ all show the spiral winding structure, and at least as far as the inner surface of the reflecting layer their interior is provided with fine chitinous, hair-like projections pointing inward Both the layers *R* and *L* are penetrated almost perpendicularly by the tracheæ which supply the air to the finer tracheoles connecting them, these tracheæ are usually simple and nearly straight in their course through the reflecting and photogenic tissues though forked and curved tracheæ in these layers are occasionally met with Throughout their length through the photogenic layer the tracheæ send out very fine branches, the tracheoles which anastomose with the tracheoles from adjacent tracheæ, forming a network of fine passages around the cells of the photogenic tissue These tracheoles are so small as to appear merely as lines even under a powerful microscope Each tracheæ as it passes through the luminous layer is surrounded by a cylindrical mass of cells of a character quite distinct from those of the true light-giving tissue and under the microscope these cylinders show as non luminous spots on the background of light in the living insect Fig 2 represents this finer structure *a* in vertical and *b* in horizontal cross-section

In the four American species of Lampyridæ which have been studied—*Photinus marginellus P pyralis P consanguineus* and *Photuris pennsylvanica* these structures have been found to be identical and it is probable that they are very similar as regards their general character in all species of this family There are some slight differences in minor points even among the local species however for instance in *Photuris* the thickness of the true photogenic tissue was found to be very much less than in *Photinus* both actually and in proportion to the thickness of the reflecting layer and the tracheæ seem to be a little more sparsely distributed through the luminous layer This may have some relation to the fact which has often been observed that the light of *Photuris* is more greenish than that of *Photinus*

While the Lampyridæ constitute the largest class of light-emitting insects one other family of Coleoptera includes several brightly luminous species—the group *Pyrophorini* of the family Elateridæ the best known of which are the Cuban cucuyo *Pyrophorus noctilucus* and the smaller elaterid firefly of our Southern States *P Physoderus* The former has been the most studied and a few words regarding it will not be amiss The cucuyo is a large hard shelled snapping beetle or elater and emits light from three photogenic organs, two on the dorsal side of the thorax and the third on the ventral side at the forward end of the abdomen The emitted light is very similar to that of the Lampyridæ in quality but differs in that it is continuous, varying in intensity but not being entirely extinguished under ordinary circumstances. In structure, the light-emitting organs are very like those of the Lampyridæ. Under the outer chitin (which is thicker and harder than in the Lampyridæ) is a layer of true photogenic tissue, and back of this is a reflecting layer, the whole being

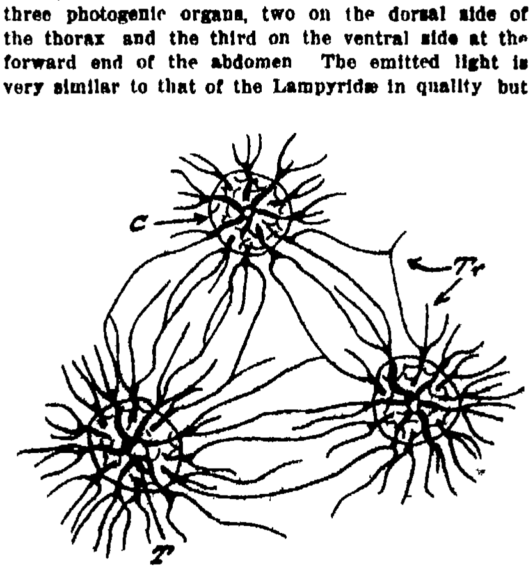


Fig 2b —Cross Section (Horizontal) Through Three of the Vertical Tracheæ Within the True Photogenic Tissue, Showing Cylinders *C* and Tracheoles *Tr*

[1] μ = 0 001 mm = 0.00004 inch

supplied with air through a system of tracheæ connecting the main respiratory system of the insects, in very much the same way as the more common insects.

Still another group of luminous insects should not be passed without mention although regrettably no studies have been made as to the structure of their photogenic organs. This group is the *Phengodini* of which a few species are known in the United States. All species appear to be rare In this remarkable group the females, in their adult stage retain the form of larvæ, while the adult males are provided with powerful wings though with only short elytra, and have very large eyes. The larviform

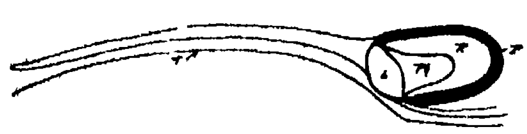


Fig 3a—Section of Photogenic Organ of Histioteuthis Rüppelli a Cephalopod After Hoyle

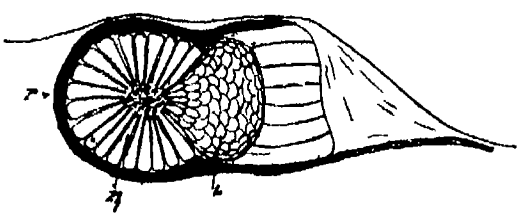


Fig 3b—Section of Photogenic Organ of *Chauliodus* Barbatus a Deep-sea Fish After von Lenderfeld

L, lens M external mirror P pigment layer Ph photogenic body R, internal reflector

females are very luminous there being two or three luminous organs at each segment and sometimes additional organs at the head More remarkable yet the light emitted from the organs of the body is different from that emitted from the organ at the head the former being greenish or bluish and the latter reddish. These insects are very beautiful though but rarely seen The males of some tropical species are said to possess photogenicity but no light has been observed from the males of our species

Of the other insects which have been reported to be luminous, but little can be said No confirmation has been found obtainable of the statement of Latrielle that the brilliant *Buprestis ocellata* of India is luminous the spots to which luminosity is attributed are upon the elytra and if they are realy luminous it is a very anomalous case So far as the Fulgoridæ the lantern flies are concerned it seems to have been pretty definitely shown that they are not photogenic under ordinary circumstances It would be interesting to try Waxasé s test by placing the supposedly luminous beaks of these insects in dilute ammonia when according to this author if they are really photogenic organs light should be evolved The light of the luminous midgets will o the wisps ignes fatui etc appears to be due to the infection of non photogenic insects with bacteria having this power and is therefore not properly classed with that of the true photogenic insects

Next to the luminous insects the most brilliant luminous forms seem to be the cephalopods—the cuttle fishes Prof C Chun and Prof W E Hoyle have made interesting studies of these organs but the

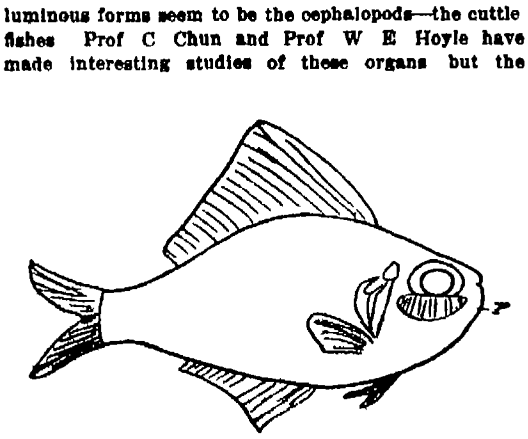


Fig 4a—*Photoblepharon Palpebratus* After Steche Showing Location of Large Photogenic Organ *P*

actual number of times at which they have been observed to emit light is surprisingly small With the Cephalopoda we may consider certain of the luminous fish, many of them caught at great depths in the sea, since some of their photogenic organs are not unlike those of the cuttlefishes. The organs which we will first describe are those classed by Prof. Hoyle as "non-glandular" In both the fish and the cephalopods these organs present a typical 'searchlight" structure. The organs are inclosed within protuberances on the creature s surface and each consists of a layer of dark pigment cells *P* a reflector *R*, a photogenic mass *Ph* and a lens *L* Fig 3a, adapted from Hoyle, shows this structure as seen in a cephalopod and *b* shows the same type of organ from a deep-sea fish, adapted from Von Lendenfeld In the cephalopods these organs have been said to emit very brilliant lights of various tones of red yellow and blue as well as white and greenish In the fish the emitted light appears to be of a pale greenish color not unlike that of some fireflies The photogenic tissue proper in the luminous organs of this class is richly supplied with nerves and blood vessels, and it is probable that in them, as in the Lampyridæ the photogenic process is one of oxidation the oxygen however being supplied to the tissue through the blood of the animal instead of being directly applied in the gaseous state from the air

An interesting point to be noted here is the location of these photogenic organs in marine forms. Hoyle mentions that in the Cephalopods the great majority of the organs on the body are directed downward In this group of animals, however many species are provided with photogenic organs situated immediately upon the eyeball a situation which leaves but little doubt of its usefulness to the bearer It has also been noticed that in the luminous fish the photogenic organs frequently are arranged so as to present the appearance of two or more parallel rows of bright points when the creature is viewed from below The fishes also very frequently have luminous appendages barbels etc where the photogenicity undoubtedly has an alluring significance and further while as yet no true fish has been found with photogenic organs situated upon the eyeball as in the Cephalopods a number of fish have been observed to have such organs situated in close proximity to the eye in such a way as to undoubtedly assist the vision of the creature

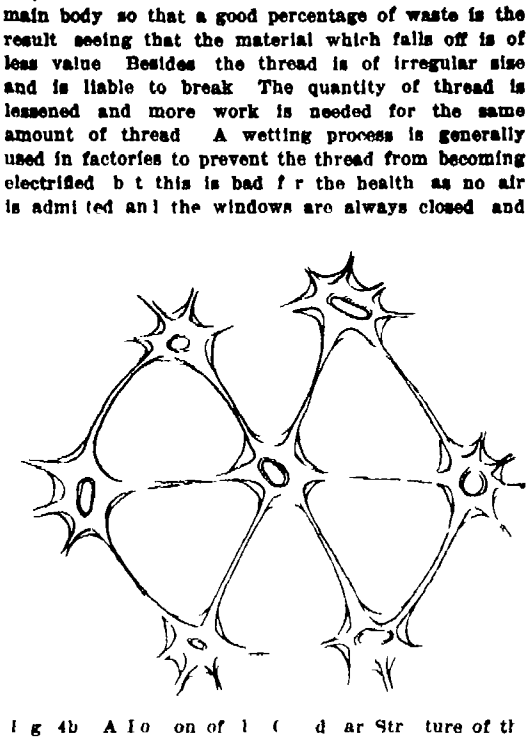
Another different type of photogenic organ is also found in a few Cephalopods and in a number of fish this is the strictly glandular type of organ in which the luminous process is restri ted to the interior of the organs Dr Otto Steche has made some interesting observations upon the structure of these organs in the fishes known as *Anomalops katoptron* and *Photoblepharon palpebratus* The photogenic organs of these species are the largest both actually and in proportion to the size of the fish so far observed The creatures themselves are very small—8 to 10 centimeters long—and the luminous organs occupy an area immediately below the eye-socket Dr Steche states that the lumino s tissue proper is a typical gland Although the process of light production by these organs must be very different from that in the organs of the Lampyridæ some of the structures remind one very much of those in the insect organs Figs 4a and b taken from Steche s paper show the location of the light-organ and a section of a portion of the gland respectively

Another interesting type of luminous organ is present in at least one species of Cephalopod in the mollusc *Pholas dactylus* and in certain myriapods These are organs that secrete a mucus which is discharged into the air or water and there becomes luminous through oxidation Organs of this type are of course true glands and tho gh their structure in different creatures need not be the same their functions are very similar Dubois has made a very extensive study of the glands of *Pholas* the interesting luminous bivalve that has formed the basis of the oldest scientific observations of biophotogenesis on record The structure is not distinctive being typically glandular but a reproduction of one of Panceri s drawings Fig 5 showing the location of the organs is given herewith

It is a little difficult in view of the wide diversity of the structures of the photogenic organs and the variations in the modes of light production to ascribe to the photogenic function of all forms a common origin In the majority of cases the photogenic tissues appear to be a derivative or extension of the adipose tissues of the organism It is certain that in a considerable number of forms of very different habitude and structure Nature has reached the point of the production of the cheapest form of light by very different methods—that is living creatures belonging to widely separated groups and families and even orders and kingdoms may produce light of very similar quality and spectral constitution through the agency of very different structures Surely among these various methods there should be at least one which would offer possibilities for artificial reproduction But for the realization of this we must as yet look to the future.

Textile Manufacturing

In the manufacture of textile and other products such as wool silk, paper or fiber in order to obtain a good quality and avoid too much waste of material, it is required to resort to methods which are very objectionable from the standpoint of hygiene For instance in the preparation of wood threads these become electrified and this causes the fibers to spread out, and a considerable amount is detached from the main body so that a good percentage of waste is the result seeing that the material which falls off is of less value Besides the thread is of irregular size and is liable to break The quantity of thread is lessened and more work is needed for the same amount of thread A wetting process is generally used in factories to prevent the thread from becoming electrified b t this is bad f r the health as no air is admi ted an l the windows are always closed and



I g 4b A I o on of l (d ar Str ture of tl Photogenic Organ of *An mal ps kat η tr n* After Steche

besides the rooms ar much overheated The excess of dampness is also a disadvan age in that it causes the products to stick to the m hines and th s is anotl er source of waste Electrical n ethods have been tried such as distributing an electric charge along the machines by insulated conductors so as to annul the static charge Induction coils or electro static machines were used b t without success for various reasons High tension alternating c irrents are too dangerous to use here New experin ents were made in France by M. Paillet and in an acco nt presented to the Académie des Scien es he states that he secured good results by using c rrents of high frequency and high tension such as e used in electro medical work af er the researches of Professor D Arsonval and others and nore re ently in wireless telegraphy Such c rrents have no la ger and much power can be used without any harm Condensers are supplied with high tension current from a transformer so as to give the oscillatory discharge Wires are stretched along the machines and near the textile matter and have small metal br shes s as to direct the elec ric discharge where it is nee le l Tl e results show th t the threads were s ronger and he breaking strain is from 7 to 1 per cent higher In s me cases this reached 22 pe cent The threads are more elastic about 19 per ent and tl e waste is lessened about 3 per cent On low grade wools where the waste is high this is lessened ev n by 28 per cent Bette hygiene can be observed as air in the rooms

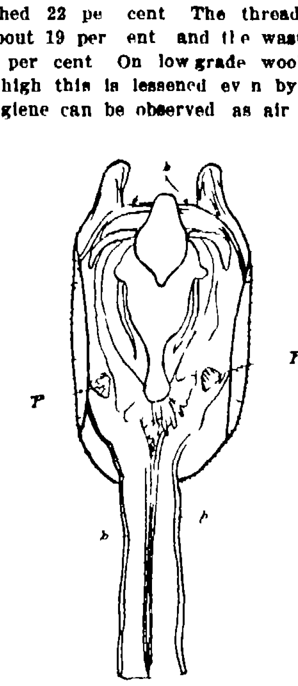


Fig 5—*Pholas Dactylus* (After Panceri) Showing Location of Photogenic Organs *P* and Parts Ordinarily Luminous From the Mucus Secreted by the Organs *p*

need not be as damp and the heat is less In this way the work is carried on under much better conditions in every way

Dynamics of the Flying Machine*

Some of the Dangers of Mechanical Flight.

By James S Stephens, M. W S. E.

It should be understood that while it is the writer's belief that this paper contains a plausible theory to account for some of the dangers of mechanical flight he hopes it will be chiefly instrumental in interesting some of the engineering profession who have heretofore given the matter little serious thought or attention also that it may promote a discussion of some of the phases of the question and thus bring out information that may assist in the advancement of the art.

The writer is aware of the fact that some of the statements and deductions made herein when considered from certain viewpoints are not in accord with the laws of dynamics as commonly accepted but this in his opinion should aid rather than prevent a liberal discussion as some of the peculiar conditions involved may cause the majority of those who consider the matter to at least question the exactness of some of the laws of dynamics as commonly understood when applied to the operation of a flying machine

During the past decade public opinion of the flying machine may be said to have passed through three stages

First viewed as ridiculous then as sublime and now on account of the great number of fatal accidents which have occurred as tragical

All of these accidents have had some specific cause and numerous explanations and theories have been offered to account for them Unfortunately the man who would have best been able to offer a satisfactory solution has in practically every case lost his life

Theories have been advanced by some of the aviators blaming the so-called *Swiss cheese* sky and *holes in the air* for many of these accidents

It is generally admitted that there are many varying currents in the air and that these changes of speed and direction in the motion of the air are undoubtedly greater near the surface of the earth than they are higher up and while some of the difficulties of flying are chargeable to this cause it has the writer believes been blamed for a great deal more than it is accountable for Such variations as do occur in the trend of the wind or air currents are not sufficiently abrupt to make flying extra hazardous from that cause alone

Once a machine is off the ground it would be immaterial whether the wind was blowing steadily in one direction 1 mile or 100 miles an hour if it were not for the fact that it is necessary to give due consideration to the laws of inertia acceleration retardation momentum centrifugal force and gravity in their proper relation to the speed of the machine both relative to the air and relative to the earth

The writer will not undertake to discuss in mathematical detail these various factors governing the conditions of mechanical flight but will confine himself to some simple illustrations which he believes will provide an explanation of the causes of many of the aeroplane accidents which have lately happened

In still air a flying machine in maneuvering in a horizontal plane would have to accommodate itself to practically the same conditions as a vehicle on the ground In starting up increasing or decreasing the speed the inertia of the weight of the machine must be overcome thus introducing the elements of time and power In turning some positive resistance such as banking the machine must be depended upon to counteract the centrifugal or tangential forces

All of the men who have flown these machines have learned to do so in comparatively still air and have been thoroughly familiar with the conditional requirements just referred to as a result of their experience with vehicles running on the ground

Flying in a wind the writer believes introduces the effect of some of Nature's laws in a way that up to the present time has not been fully appreciated and therefore has not had the consideration which is due

To illustrate imagine a machine flying at the rate of 40 miles an hour which is in round numbers 60 feet per second directly against a wind blowing at the same speed While such a machine would maintain itself in the air just as surely and safely as if it were flying on a calm day and covering a distance of 40 miles an hour as measured on the earth's surface it would in fact actually be standing still in so far as its relative position to the earth is concerned and the entire output of its engine would be expended in supporting it against the action of gravity and preventing it from drifting backward in the wind

Now for the sake of the illustration consider what would happen if the 40-mile wind could be suddenly stopped The machine having no initial velocity or momentum could get no support from the air until it could acquire a sufficiently high relative velocity This on account of inertia, and the limited power available requires time and during such time-interval the machine must fall While the abrupt stopping of a 40-mile wind is not possible a somewhat analogous condition may be brought about by an abrupt turning of the machine when it is stationary relative to the earth through flying against a high wind as above mentioned

Under the most favorable conditions it would take considerable time to bring a machine weighing about 1 200 pounds from a standing position up to a speed of 60 feet per second or double this speed as the writer will endeavor to show may be necessary under certain practical conditions

The following is quoted from *Aircraft* the December issue describing the flight of Johnstone and Hoxsey at the Belmont Park international aviation meet both of whom have since lost their lives as martyrs to the cause of progress They faced the wind coming in from the ocean and as they went higher their speed in relation to the ground rapidly diminished as that of the air they were meeting became greater Soon they appeared to be standing still the velocity of the wind being just even to theirs (about 38 miles) and then as they went higher they started to lose ground and the higher they went the faster they went backwards Close together they appeared like two great kites on a string—a string being slowly paid out

How great a wind Johnstone faced at his maximum altitude of 8 500 feet no one can say but with his machine going close on to 40 miles an hour he was blown backward some 40 miles in the course of less than two hours and 75 miles an hour is not an exaggerated estimate of the maximum velocity of the wind met by him

Brookins Johnstone and Hoxsey on Wright machines have made complete circles in the air in about six seconds Let us suppose one of them had undertaken to make such a turn when flying against a head wind a quarter of a turn would be made in less than two seconds with the result that whereas the machine before the turn had the necessary supporting power to maintain it in the air in less than two seconds of time it would have turned around a quarter of a turn in the air and with respect to its relative position to the earth would have practically turned upon its own center and have begun to drift sideways having practically lost all of its sustaining power it had no initial forward motion when commencing to make the turn the time allowed not being sufficient to acquire the necessary acceleration and the power available not being great enough

Should he be able to get his machine around a full half turn which he might be able to do in three seconds the machine even though assisted by all the power of its engine and the effect of the wind in the direction it had turned could not in that limited time have gotten up sufficient headway against its own inertia so as to be moving as fast as the wind itself and the wind would actually be blowing from behind and aiding gravity in forcing the machine downward It seems hardly probable that under such conditions it would be possible for the operator to again right the machine even though it were falling head first especially if he was not aware of the actual cause of the trouble

As a matter of fact a machine under such conditions as above outlined would in so far as the forces of gravity and inertia are concerned have to start from a standstill and acquire a velocity of 80 miles per hour relative to the earth before again obtaining its normal supporting power of 40 miles per hour relative to the air in which it would be flying

A further complication would be the fact that once commencing a turn under the conditions above stated the machine would have a tendency to turn practically on its own center and having thus acquired an initial rotary motion with little forward motion in the same plane it would be much harder to check or reverse the turn Any effort which might be made by the operator would probably be such as would result in just the reverse to that intended, as the conditions of support would for the time be reversed

The support of a flying machine in the air depends upon a nice adjustment of the speed relative to the air its surface and power as opposed to the action of gravity The power may be so applied when flying as to store up within the machine dynamic force which would be the product of its speed relative to the earth and its weight, or simply to overcome the static force caused by gravity, if the machine were flying against a wind blowing at the same speed required for sustention In fact if the machine were flying against a wind blowing relative to the earth at greater speed than the speed of the machine through the air it would then have stored up within itself dynamic force acting in the opposite direction to which the machine would be actually moving through the air

It seems evident that a flying machine may be turned very quickly and may on account of the small frictional hold it has upon the air and due to momentum, or centrifugal force skid a considerable distance in making a turn unless the resistance available by banking the machine is adjusted very nicely to the relative forces brought about by the speed of the machine

It is the writer's belief that such quick turns if made in a wind are extremely dangerous and are responsible for at least some of the fatal accidents which have occurred

Prof Langley the writer believes was the first to compare the flight of an aeroplane to a skater passing rapidly over thin ice which would sustain him safely so long as he maintained sufficient speed to distribute his weight over a sufficient area Let us go a little further with this illustration we know that the skater might turn his body around while passing swiftly over such thin ice and still continue on in safety but should he check his speed and endeavor to reverse the direction of motion he would surely break through So with a flying machine if turned too quickly its momentum would tend to carry it along in the direction in which it had been flying until it reached a critical position without sufficient support from speed in the direction it had been turned

Safety in either case could be assured only by making a long turn that would meet the requirements of time weight and surface and while the skater might turn on his own center skating either face forward or backward without affecting his safety so long as he maintained his speed the flying machine must of necessity at all times present its front directly toward its direction of motion and at the same time maintain its proper angle of incidence and forward speed relative to the air to prevent its falling

This essential condition that the machine must be moving at its full speed relative to the air and in the direction it has turned irrespective of the speed of the wind or the relative speed of the machine to the earth and the fact that such changes in direction when flying in a wind may bring about or require rapid changes in the actual velocity of the machine itself so that at all times it may have a normal speed relative to the wind is the writer believes responsible for conditions which we have not had to consider in other methods of transportation prior to the advent of the flying machine

It is believed that a greater power is required to get a machine off of the ground than that necessary to maintain it in the air in horizontal flight

If making a flight in still air the machine might start in any direction on level ground The power required would be that which would be necessary to overcome the head resistance of the air the frictional resistance of the air the action of gravity and the inertia of the weight of the machine in bringing it up to the speed necessary for sustention in a given time After attaining this speed that portion of the power required for overcoming inertia would remain in the machine as kinetic energy and when flying in still air would remain constant irrespective of the direction in which the machine might be flying

If a machine were started from a stationary position on the ground against a head wind blowing at a speed equal to that necessary for the support of the machine no power would be required to overcome the inertia of the machine in a horizontal plane It would maintain its relative position to the earth and if it were possible for the wind to instantly stop blowing the machine would fall during the time necessary to accelerate the machine up to a speed necessary for support

If a machine were started from a stationary position on the ground moving in the same direction with a wind blowing at a speed equal to that necessary for the support of the machine, it may be assumed that, if sufficient time is allowed, the force of the wind will accelerate the speed of the machine up to the speed of the wind, but from this time until the machine obtains a speed necessary for support greater than the speed of the wind, the same elements of resistance will have to be overcome as in starting from the

* Read before the Western Society of Engineers

turning in still air, including the power and time necessary to overcome the inertia of the machine.

The above statements, the writer believes demon strate the fact that in flying in a wind and making a turn, the necessity for quick changes in the actual velocity of the machine, required to accommodate the speed of the machine to the speed of the wind when the direction of the machine is changed may be such as to cause the machine to fall for want of sufficient surplus power to meet such variable conditions, or on account of not allowing sufficient time for the small amount of power available to meet the requirements of changes in the actual velocity of the machine

In flying in a wind it would seem as if there must always be a variable resistance or momentum to be considered when making a turn that this variable will be proportionate to the speed of the wind and must be provided for when turning by the allowance of ample time for increase or decrease of the actual speed of the machine so that it may at all times maintain its normal speed relative to the air Also that, in making such adjustments of time and speed the weight of the machine the normal speed the amount of surface and the surplus power available will all have to receive due consideration—in the hands of an expert operator who has become thoroughly familiar with these conditions and their relative values—if safety in flight is to be attained

A flying machine cannot without risk of falling be turned in its course through the air without allowing the necessary time relative to the power and weight to overcome its inertia and maintain its speed in the direction it has turned

For the sake of argument consider what would actually happen to a flying machine weighing 1 000 pounds *moving through the air* at the rate of 60 feet per second or 40 miles per hour and making a complete turn in the air in six seconds while the wind was blowing at a speed of 40 miles per hour the turn to commence when the machine was flying against the wind and practically standing still relative to the earth In making such a turn in still air the machine would traverse a true circle about 360 feet in circumference both in the air and relative to the earth commencing and completing the turn with the normal speed *necessary for sustention* 60 feet per second in the air and relative to the earth s surface at all points of the turn

In making a turn in the air with the wind blowing 40 miles per hour the machine would if it were not *for the effect of inertia* traverse a true circle relative to the air just as when turning in still air but relative to the earth it would move in the direction in which the wind was blowing 60 feet per second But on account of inertia, in making such a complete turn the weight of the *machine* 1 000 *pounds* would have to be accelerated from a standing position to a speed of 120 feet per second in the first three seconds of the turn and retarded from this speed to a full stop in the last three seconds of the turn

As a matter of *fact* a flying *machine may be* turned around in about six seconds and with comparative safety in still air but to make such a turn and at the same time increase the speed of 1 000 pounds weight to 120 feet per second and again retard it the same amount in six seconds is beyond the power available for acceleration or the strength of the machine to act in retardation especially if we consider the fact that the power available for acceleration would be very small practically all of the power being actually necessary to support the machine in the air The amount of power available over and above that required for sustention may be approximated by the ability of the machine to rise For instance if a machine weighing 1 000 pounds were capable of rising 100 feet per minute, this would indicate that it had 3 horse-power or 100,000 foot pounds per minute of surplus power above that required to maintain speed of sustention Three seconds is one-twentieth of a minute so that we would have 5,000 foot pounds available for three seconds to increase the velocity of 1 000 pounds weight to 120 feet per second It would take about 140 000 foot pounds to do this in three seconds or about a minute and a half to accelerate 1 000 pounds weight with the energy available 5 000 foot pounds

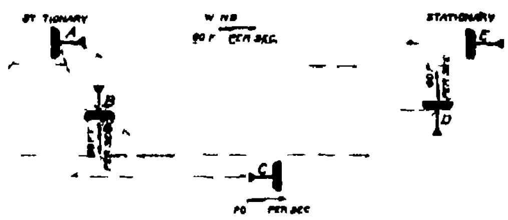
These figures are merely approximations made to illustrate the conditions involved

The wind would assist in acceleration on the first half of the turn and the resistance of the air to forward motion would help decrease the time necessary on the last half of the turn This would materially decrease the time required for the complete turn The arbitrary conditions mentioned herein are used for illustration only The actual time in which a safe turn may be made in the air may be closely estimated if we have the weight of the machine know how much surplus power it has know the speed of the machine relative to the air and the speed of the wind

The product of these factors would be varied somewhat by the area of the surface of the machine the form of the machine and the ability of the operator to control it to the best advantage

A diagram may be made graphically showing any *combination of the conditions* governing *the turning* of a flying machine in the air

To illustrate the conditions above mentioned the following method is suggested



Let *A B C D* and *F* represent five different locations of a machine relative to the earth when flying 40 miles per hour against a wind blowing 40 miles per hour and making a complete turn the dotted line representing the course of the machine relative to the earth in making the turn and *A B C D* and *F* relative *positions of the machine during the turn* The machine would be standing still at *A* It would have turned a quarter of a turn and increased its speed to 60 feet per second at *B* half a turn and a total acceleration of 120 feet per second at *C* three *fourths of a turn and retarded 60 feet per second at* *D* and a full turn to a stationary position relative to the earth at *E* It would therefore appear that such a turn could not be made safely in much less than a minute and a half under conditions previously stated

If the machine were flying in still air it would have completed a true circle both relative to the air and earth and location *E* would coincide with location *A* on one side of the circle This it might do safely in a few seconds of time

Such a diagram might be made to show time weight distance speeds etc and their relation to each other for any specific construction of machine and in this way establish limiting conditions which would be a guide to the aviator in governing the movements of the machine so as to be able at all times to keep it under safe control

It is believed that some of the accidents referred to have been due to a combination of the above named causes and the failure of the aviator to appreciate their varying influence as compared to his speed through the air and his relative speed over the earth due to the speed of the wind It is only when quite near the earth that the relative speed of the machine may be judged of when higher up the aviator s attention is given to necessary adjustments to meet the changing conditions in the air

On approaching the ground he has no way of determining the direction or speed of the wind except by noting some object such as smoke or a flag or by first flying in a circle near the earth and noting the *amount and direction of the side drift of the machine* And it must be admitted that to do this even approximately must require a highly cultivated sense of speed and direction Any speed indicator placed upon a machine can only show the speed through the air Nevertheless such an instrument is of the highest importance as a guide to limit speed in gliding and to maintain necessary speed for sustention It is quite possible that accidents have occurred on account of lack of knowledge of these relative speeds

This paper has been presented with a belief that it will give rise to a discussion of the subject which may lead to further investigation and perhaps develop a greater interest in the possibilities of the flying machine from the standpoint of the engineer

The writer has long been interested in this subject and determined about a year ago to commence the construction of an experimental machine with a view to in some measure safeguard the operator by devising a construction which will he believes have a large margin of natural inherent stability in the air

Before commencing this construction he had become thoroughly convinced that a machine could be built to meet the following requirements which it is believed are fundamentally essential to safety in flight

1st That the machine should be designed so that without manual control it will automatically assume and maintain a straight horizontal line of flight when operated under power and a proper minimum gliding angle forward when the power is shut off

2nd It must at all times automatically maintain its transverse stability when in flight or when gliding *without attention of the operator or the intervention* of intermediatory mechanically operated devices

3rd It must be capable of being positively controlled by the operator by a single simple controlling member to accomplish all of the operations of steering in *any direction or of changing the lateral inclination* of the machine to meet unusual requirements which may be met with in flying or brought about by the operator in steering

4th Such a machine should be built so as to have the same factor of safety relative to the strains involved in actual flying conditions as would be allowed for any other refined construction upon which it is intended to carry the risk of human life

These requirements have been stated simply to indicate the line of thought which has led up to a belief that some combination of the conditions as outlined in this paper have been responsible for a number of the fatal accidents with flying machines

Acrobatic stunts and thrillers involving quick turns have been accomplished with apparent safety by competent aviators in still air To attempt such demonstrations in a strong wind whether it be blowing steadily or not before we know definitely about all the various factors involved in safety in flight seems to be an endeavor to beat some of the well known laws of the resistance of weight to a change of motion and likely to prove suicidal for the experimenter

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Canada s Asbestos Industry

CANADA produces 82 per cent of the world s supply of asbestos The companies operating asbestos quarries and factories in the Dominion are capitalized at $24 290 000 In 1880 only 380 tons of asbestos were produced valued at $24 700 whereas in 1909 the production amounted to 63 300 tons, valued at $2 300 000 In 1909 3 000 men were employed in the asbestos industry and received wages amounting to $1 350 000 These facts and much valuable technical information of practical value to the general public are contained in a finely printed and well illustrated volume of 316 pages, just issued by the Mines Branch of the Department of Mines Ottawa This valuable addition to the series of monographs being issued under the direction of Dr Haanel was written by Fritz Cirkel M E and treats the subject of asbestos from every viewpoint history geology peculiarities of Canadian occurrences, quarrying and milling together with statistics, cost of extraction, its occurrence in foreign countries, and its practical application in the arts and manufactures To give an idea of the enormous reserves in some of the asbestos deposits, Mr Cirkel mentions the case of one, the Blake Lake quarries Quebec, where there are some 45,000,000 tons of asbestos rock in sight The author goes fully into the discussion of foreign asbestos occurrences and considers Russia the only real rival as regards extent of asbestos resources But inasmuch as the Russians are heavily handicapped by the excessive cost of transportation—$35 to $40 per ton to London—serious competition is not feared in the leading markets of the world Dealing with the practical application of asbestos Mr Cirkel lays special emphasis on the prospective increased use of asbestos in the manufacture of slate He says on page 246

It will not be long before the asbestos slate or shingle business which is just commencing to be felt will push its way more and more to the front Indeed it is not too much to say that the time is not far distant when fully 75 per cent of all asbestos produced in the world will be used in the manufacture of asbestos slate and shingles The asbestos slate business is only four years old but during that short space of time the demand for this article has increased to such an extent that factories for this purpose are being established all over the world

The report covers over three hundred pages containing 66 photo-engravings, 88 drawings and two maps of the Quebec asbestos districts. It is one of the handsomest practical technical reports that has been issued by the Dominion government

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G O CASES an English engineer has suggested a novel type of reinforced concrete in which wooden beams and laths take the place of iron rods and wires The new *material* which its inventor calls ligno-concrete is intended as a substitute not for ferro concrete in general but chiefly for wood as employed in the construction of roofs footways posts et The wooden parts acts as traction members and the concrete as a compression member

It has been demonstrated by many tests that ligno concrete is as strong as ferro-concrete when the wooden beams of the former have a cross-section which makes them as strong as the steel bars of the latter The tractile strength of steel is eight or nine times that of wood but steel is ten to fifteen times as costly as timber Hence ligno-concrete if it proves durable may advantageously be substituted for ferro-concrete in many cases The question of durability can be decided only by time and experience but the many known instances of the permanence of wood protected by cement indicate that the decision will be favorable

New Researches on Quartz Lamps

Leblanc's Experiments

AS THE result of a series of researches made at Paris by M Maurice Leblanc upon the properties of quartz mercury vapor lamps he has succeeded in constructing a lamp which gives a much greater economy than the usual mercury lamp and at the same time he has greatly improved the color of the light so that it approaches the quality of white light At the same time the power consumption has been greatly reduced amounting to only 0 25 to 0 30 watts per candle power a figure hitherto attained only by flaming arc lamps which however have many disadvantages such as rapid wear of the carbons difficult regulation and necessity of frequently cleaning the globes The new quartz lamp will burn for 1 000 hours and involves no continuous consumption of perishable material In point of running expense it appears therefore to be the most economical lamp existing though the first cost of manufacturing the quartz lamp is of course high M Leblanc gives the following account of his researches

In the mercury vapor lamp the amount of illumination which is produced for a certain given power depends upon the pressure of the mercury vapor in the tube This relation is quite variable however For the ordinary mercury lamps in which the pressure is about 0 04 inch of mercury the ratio is about 0 36 watt per candle-power and this is the best result which can be obtained with an arc in a glass tube It would be a great advantage to increase the pressure of the mercury vapor This can readily be done by working the lamp at a higher temperature—for instance by preventing the cooling of the walls of the lamp But at such temperatures the glass would melt so that in the case of a glass tube lamp a limit is soon reached beyond which the yield in light per unit cannot be raised by working at increased temperature The problem is solved however by using a quartz tube for the lamp This material is much more difficult to shape in the form required than glass and thus causes some extra expense but the resulting economy in running cost is very great This will be noticed from the fact that at pressures of about 1 atmosphere we have but 0 25 watt per candle power as compared with the above quoted figure and thus we use much less power for the same light This high temperature has also the advantage of greatly improving the color of the light which acquires a yellowish hue analogous to what certain flaming arc lamps give and is rendered more agreeable to the eye

It is well known that the quartz mercury vapor lamp gives off powerful ultra violet rays which are stopped entirely by the glass tube in the case of the ordinary vapor lamp Such rays would be dangerous to the eyes but by using a glass globe they can be quite cut off The use of quartz for the new lamp gave rise to a number of difficulties such as for instance the problem of sealing the conducting wire in through the tube So long as glass tubes were used there was no trouble in sealing a platinum wire through the glass for as the expansion of this metal with temperature takes place at very nearly the same rate as that of glass the joint always holds good But with quartz the matter is quite different seeing that the expansion rate of quartz is very low and is about eight times less than that of platinum Should we seal in a platinum wire the joint would soon give way owing to the very unequal expansion An alloy however is known which also has a very small coefficient of expansion—namely the nickel steel made by M C Guillaume of Paris and known as invar It is valuable for many purposes owing to its small expansion when heated or cooled and is used for standard measures clock pendulums etc It therefore comes in very well to match the low expansion of quartz However the invar alloy is a forged metal which loses its characteristic properties when brought to a red heat It cannot, therefore be sealed into the glass but instead is inserted by a ground joint like a glass bottle stopper so that a relatively tight joint is obtained As however there will always be slight leaks in such a joint a mercury filling is put around it and the mercury is held in place by a solid cement covering (Fig 1)

Another difficulty arises from the fact that in the mercury arc the fall of electric potential at the surface of the anode is greater than at the cathode surface and thus the anode is always hotter than the cathode For this reason there is a gradual transportation of all the mercury of the anode towards the cathode At first sight it would seem that the simplest plan to avoid the accumulation of mercury at the colder electrode would be to place this at a higher level than the other When the mercury accumulates, it would overflow and would fall back into the lower electrode But in the quartz lamp this movement of the liquid mercury would have the effect of putting out the arc for the reason that the relatively cold mercury of the electrode when passing into the very hot arc tube would be partly vaporized and there would be a sudden rise in the pressure inside the tube causing the extinction of the arc A compensating method had to be found which would automatically hold the

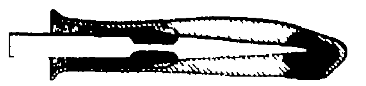

Fig 1—Method of Inserting the Invar Electrode with Mercury Seal

level of the two electrodes constant in spite of their difference of temperature This M Leblanc has succeeded in doing He connects the negative electrode with the vapor tube proper by a conical tube whose top is near the arc tube (Fig 2) Should the mercury accumulate at the negative electrode the level rises in the conical tube The arc now starts from a smaller surface of mercury, which is therefore heated more strongly giving rise to an increased evaporation Thus the mercury tends to be driven off by the evaporation Should the level be lowered

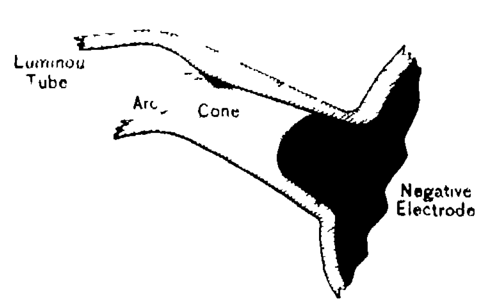

Fig 2—Arrangement for Automatically Controlling the Distillation of Mercury from the Anode

in the conical tube the reverse effect takes place and thus prevents the mercury from accumulating at the positive electrode In practice by designing the conical tube properly we secure an automatic action and this is found to work very well

Another point which requires attention is to assure proper cooling of the tube in order that the pressure of the vapor should not rise too high This cooling is effected by surrounding the electrodes by a set of copper cooling wings (Fig 3) which act as a radiator

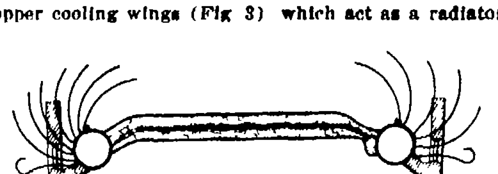

Fig 3—Mercury Lamp with Cooling Vanes or Wings

to dissipate the heat This arrangement has been used for some time past in quartz lamps Another method is to use a chamber in which the mercury condenses so as to fall back into the tube in the liquid form (Fig 4) The conditions of the tube are found to vary somewhat with the temperature of the certain size to the cooling wings or to the condensing cooling of the tube and for a given voltage used on the lamp a greater current is passed through the lamp These variations are especially noticed when

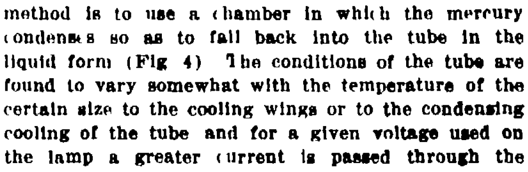

Fig 4—Mercury Lamp with Bulb-Cooler

the metal wing cooling is used In the case of the condensing chamber the temperature of this latter is always high enough so that the quantity of heat which it dissipates is but slightly affected by any outside changes in temperature The current in the lamp is adjusted at the required value by giving a certain size to the cooling wings or to the condensing chamber taking into account also the radiating surface of the tube proper

The above principles are embodied in a new lamp which has been brought out at Paris and is known as the "Westinghouse-Silica The quartz tube is mounted with an electro-magnetic device for tilting it and is surrounded by a large globe, so that it has the general appearance of an arc lamp The economy of current is almost as great as in the flaming arc, which it will be remembered has 75 per cent economy over the ordinary arc. But this is counterbalanced by the great consumption of carbons and the cost of cleaning of the globe. Briefly stated the quartz lamp has the following advantages First, absence of carbons second no cleaning of the globe is required, third better diffusion of light, owing to the fact that the source is of larger volume than an arc, fourth, no trembling of the light from mechanical regulation fifth an agreeable white and soft light, without red rays which is not harmful to the eyes.

Style in Original Scientific Articles

SCIENTIFIC ability and literary skill do not always keep company in the same individual The time spent in the acquisition of experimental skill in the laboratory perforce imposes some sacrifice upon the individual in the development of his literary faculties. Moreover, the work of the devotee of science cultivates in him attention to substance rather than to form He is more concerned with the establishing of facts than with their presentation in "flowing terms. And indeed so long as this attitude merely leads to an unembellished though perfectly clear and sound style it is entirely beneficial

Unfortunately however the matter does not end there if we may judge by complaints voiced now and again criticisms which it may be mentioned apply not only to writers in the English language but to others also The matter is referred to by Prof Sedgwick Minot in his vice-presidential address before the American Association in words which are well worth quoting

We are probably all ready to admit that the care bestowed on the presentation in print and picture of original discoveries is often insufficient. Do we not all know articles which are bungled in form and weakened by prolixity? Surely the heads of laboratories should insist by example and precept that all the workers under their influence should write clearly and briefly—for if an author fails to show respect for his own scientific work how can he expect others to respect it? Yet there are few matters so important as intensifying the world s respect for science For us, whose language is English the standard should be highest Rivarol in his famous prize essay said Ce qui n est pas clair n est pas Francais—but we might say what is not true is not English By its wealth of synonyms and its logical construction the English language is preeminently adapted to the exact statement of scientific truth We should not misuse so fine an instrument, which if well employed is sure to win for Anglo-Saxon science the wide influence it deserves Good thinking is the blastema of good style therefore our learning will never appear good if our learned articles are written badly

An Aerial Ferry

AT Rouen in France on the River Seine there is a bridge that is a sort of aerial ferry In order to avoid interference with shipping at this point it was determined to place no structure in the stream or near its surface Instead of a bridge in any of the ordinary forms a horizontal flooring sustained by steel towers and suspension cables was stretched across the river at an elevation of 167 feet On this flooring run electrically-driven rollers, from which is suspended by means of steel ropes a car that moves at the level of the wharves on the river banks, The car is 36 feet wide and 42 feet long and is furnished like a ferryboat with accommodations for carriages and foot passengers. The ropes that carry the hanging car are interlaced diagonally in such a manner that the support is rigid and a swinging motion is avoided

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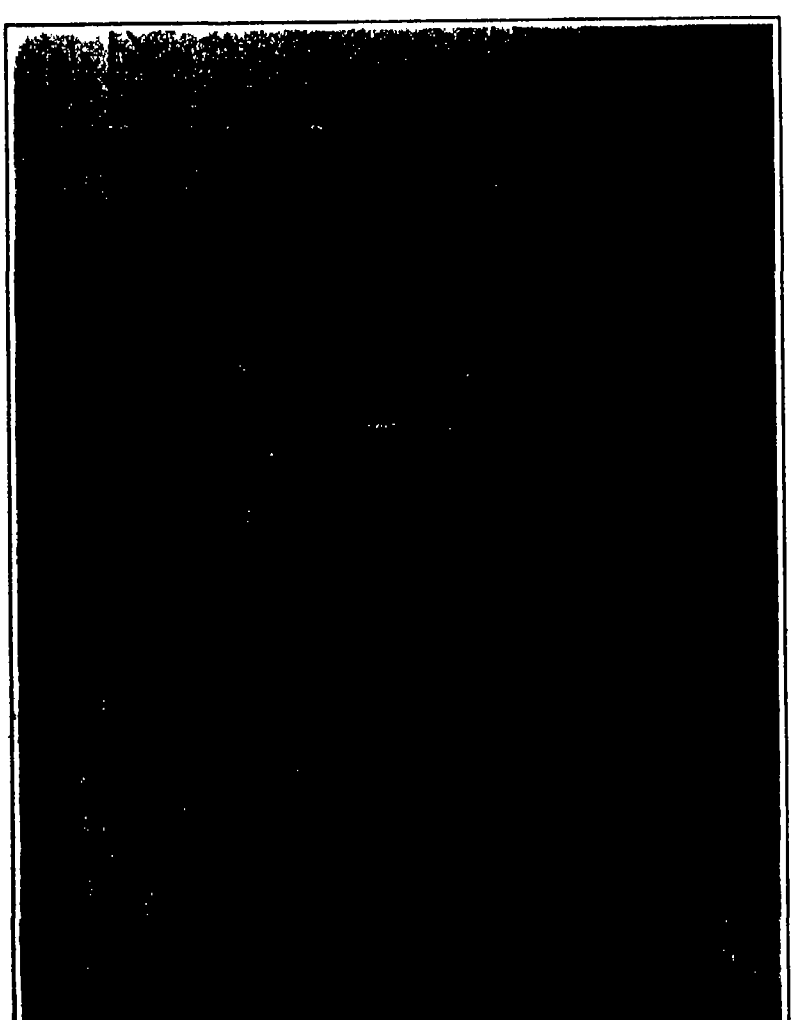
The Aeroplane Military Scout

IT may as well be recognized at once that the aeroplane can never be seriously considered as a means of transportation on any extended scale. The present indications are that a single machine can never hope to carry more than two or three passengers. For the carriage of heavy freight it is altogether out of the question, although it is possible that it may have a field of usefulness in the post office and express service for the transmission of important mail and light packages with the least possible delay.

Undoubtedly the greatest field of usefulness of the aeroplane will be in military operations, although even in this field its work will be of a limited character. Its small carrying capacity will prevent its being used on any extensive scale for the carrying and dropping of high explosives. The amount of explosive which it could take up would be so insignificant as to have no particular value for this purpose. The attack on fortifications, arsenals, dockyards, fortified camps and cities by landing within them high explosive shells can only have any decisive effect upon the outcome of a war if the high explosives can be thrown in enormous quantities. The dropping of a few isolated shells could work only a limited amount of damage, and unless they could be accurately aimed

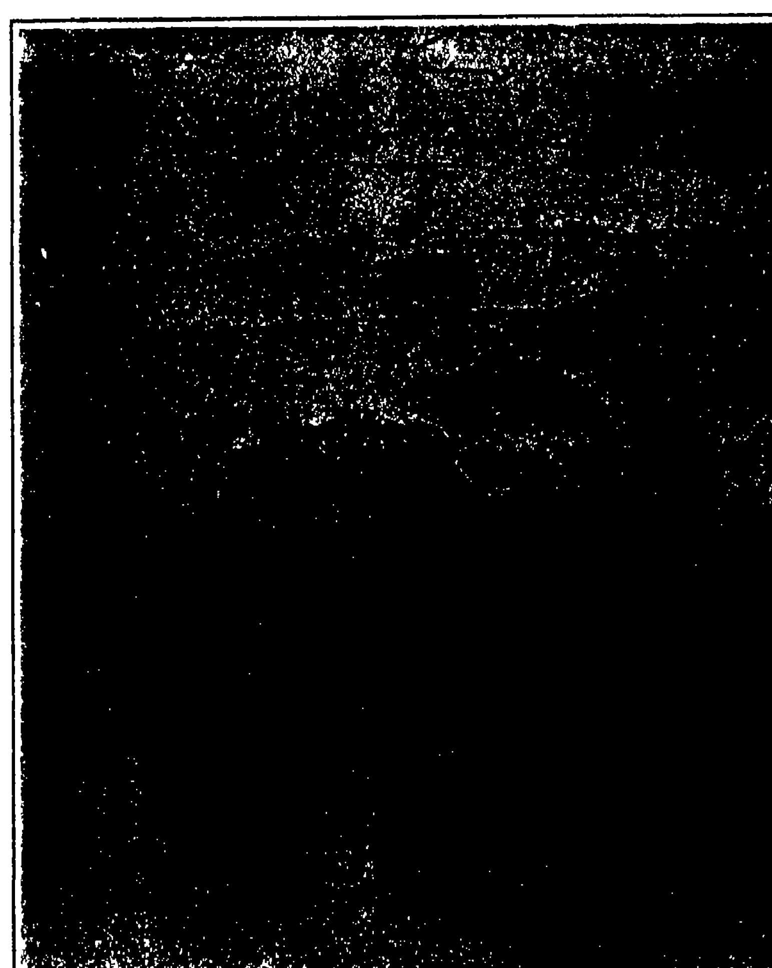
FAC-SIMILE OF A DRAWING MADE BY MR. C. FLEMING WILLIAMS WHILE FLYING ON A BIPLANE. THE SUBJECT IS THE MOTOR RACE TRACK AT BROOKLANDS, ENGLAND.

A VIEW FROM THE PASSENGER'S SEAT, SHOWING THE PILOT AND THE COUNTRY IN FRONT.



HOW SKETCHES WERE MADE IN MID-AIR BY MR. C. FLEMING WILLIAMS TO SHOW THE POSSIBILITIES OF THE MILITARY DRAFTSMAN.

Drawings reproduced from the *Illustrated London News*.



A MILITARY PLAN SKETCHED BY MR. C. FLEMING WILLIAMS FROM A BIPLANE, SHOWING THE POSSIBILITIES OF THE AVIATOR SCOUT.

THE MILITARY SCOUT AND HIS POSSIBILITIES

they would represent so much time and money thrown away Experience in bombardments has proved this fact conclusively It was only after the capture of 203 Meter Hill outside Port Arthur when the fire of the guns could be accurately directed that the heavy mortar batteries were able to do any very effective work Now to aim the one or two high explosive shells which an aeroplane could carry so that they would unerringly hit some particular point below would be a practical impossibility for reasons which it is not necessary here to enter into

From the *Illustrated London News*

A ROUGH PLAN OF BROOKLANDS MADE BY MR. C. FLEMING WILLIAMS

Mr. Fleming Williams writes [illegible] the racing track towards the hangars at a height of 45 a weird thing on which shaped like a cigar with a hud [illegible] land [illegible] as though we were sta[illegible] [illegible] roar a [illegible] of air slightly warm a little discol red with blue smoke and it [illegible] and the head of the track

The military aeroplane of the future will find its greatest field of usefulness in the important work of scouting The military scout will carry two men one to operate the machine and the other to take photographs and make reconnaissance sketches of the country The striking picture shown on the front page of this issue is no mere dream of the enthusiast It would be entirely possible for Wilbur Wright to take up with him an officer rise to a height of 1 000 or 1 500 feet sweep over 25 or 30 miles of an enemy s country and secure a thoroughly accurate sketch of the lay of the land the disposition and strength of the enemy the various roads by which he might attack or be attacked and all the other information which it would be the duty of the reconnoitering officer to secure Because of the height at which the aeroplane would travel and the uncertainty as to its speed and direction of flight it would be an extremely difficult object to hit and it would be possible for several shells of the small caliber which would be used in an attack to pass through the canvas of the aeroplane without impairing its stability

Mechanical Handling of Materials*

By Richard Devens

Manager Eastern Office of the Brown Hoisting Machinery Company New York City

Within the last few years some of our railroad industrial and steamship companies have begun to realize the important part mechanical transference plays in the quick and economical handling of material

The most efficient advances have been made in the handling of bulk material such as ore coal and grain while package freight, comprising boxes barrels bags and other packages which make up the load of a freight car or the cargo of a steamship has just begun to receive serious consideration

It is no doubt a fact that the proficiency in handling bulk material was due to the difficulties to be overcome in the transportation and handling of iron ore to the center of the iron industry

I have reference to the iron ore that was discovered in the Lake Superior country

The first problem was the transportation and this was overcome in 1855 when the federal government completed its first system of locks at the falls of the Sault Saint Marie River at Sault Saint Marie Michigan

The second problem was the loading and unloading of the vessel The loading was readily accomplished by the building of a long line of pockets on a dock extending into the lake and the equipping of each pocket with chutes The pockets were of such height that the ore would flow from them over the chutes and into the vessel by gravity The railroad cars of the bottom dump type were brought over the top of the pockets and dumped into them

It is interesting to note that the method used in the first loading dock is the one on which all docks have been constructed since

The unloading has been the most difficult to accomplish in a quick and economical manner

The first vessels to carry iron ore were not constructed for the purpose, and while they carried some ore in the hold most of it was carried on deck. When it was carried in the hold, it was hoisted to the deck by horse-power and dumped into barrows and then like the deck cargo, wheeled ashore

The next step was the substitution of a small hoisting engine for the horse-power

This early method was in operation many years, and it was not until the dock managers were forced into it by the great expense in carrying large storage on the dock that any mechanical devices were attempted

A cableway machine built and erected at Cleveland Ohio in 1880 under Mr Alex E Brown s design and supervision was the first mechanical plant

The next machines were of the bridge type

The method of handling the iron ore over either the cableway or bridge was to fill iron buckets by hand in the hold of the vessel and then hoist them by the machine and dump them automatically into railway cars or storage In the hold there were from twelve to fifteen shovellers to each machine and there were two men on the machine one an operator and the other a fireman

Both of the above equipments were a great improvement over the early methods and handled the iron ore in a satisfactory manner yet they did not cut down the cost of the hand labor in filling the buckets in the hold This was a very large part of the cost of unloading

An automatic filling bucket had been worked successfully for a number of years in coal and similar soft material but on account of the hard and lumpy nature of the early iron ores it could not be operated in them

With the use of the soft Messaba ores interest in the automatic filling or grab bucket was renewed and about ten years ago the first successful grab bucket machines were erected and operated at the Illinois Steel Company s plant at Chicago by the Hoover & Mason Company This plant was designed to unload from the vessel direct into railway cars

The success of this plant was the beginning of the present methods of unloading iron ore

There have developed two types of grab bucket machines one with the grab bucket suspended from wire ropes and the other with the grab bucket carried on a rigid arm

The cost of filling the buckets by hand was about 13 to 15 cents per gross ton, and the cost of hoisting and dumping into railway cars or storage from 1½ to 2 cents per gross ton, making the total cost of unloading from 14½ to 17 cents.

With the grab bucket machines, this total cost has been reduced to from 1 to 2 cents per gross ton, depending on the distance the ore is carried from the vessel

The hand-filled buckets were of about 1 ton capacity, as this size had been found to be the most practical for filling and handling in the hold.

With the grab bucket the size is only limited by the dimensions of the hatch and the shape of the vessel

The first grab buckets for iron ore were of 5 tons capacity but since then machines have been built to handle 7½ 10 and 15 tons

Besides reducing the cost of unloading the ability to handle in larger units has reduced the time whereas with the hand filled buckets to unload a 6 000-ton vessel was a question of days, it is now only a question of hours

The steamer Morgan of the Pittsburg Steamship Company with a cargo of 11 319 tons of ore was recently unloaded at Fairport in five hours and fifty eight minutes The work was done with six Brown Electric Unloaders

These improvements have also increased the earning capacity of the vessel by making possible a greater number of trips during the season This is shown by the following comparative statement for the years 1906 and 1910 showing the average stay at upper and lower ports of the vessels of the Pittsburg Steamship Company

	Year 1906		Year 1910	
	Hr	Min	Hr	Min
Average stay in lower lake ports	36	15	22	22
Average stay in upper lake ports	22	25	12	22
Average time spent in port receiving and discharging cargoes	58	38	34	44
	Gross Tons		Gross Tons	
Average cargo carried	5 954		6 634	
Largest cargo carried	13 333		13 296	
	In 70 Min		In 45 Min	
Fastest loading record	9 277		9 788	
	Tons per Hour		Tons per Hour	
Rate of fastest loading record	7 280		13 051	

In the foregoing I have outlined the development of handling bulk material using iron ore as an example The handling of package freight has not been brought to the same degree of perfection

In many manufacturing concerns mechanical devices have been installed to reduce the cost of handling and to hasten the transportation of their products but for quick and economical handling of freight at shipping docks and railway terminals little has been done in this country

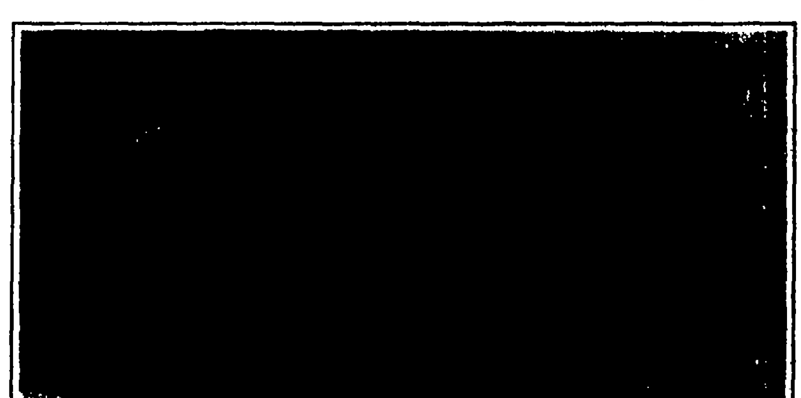
In Europe greater advances have been made due largely to the encouragement given by the city or government which frequently itself equips the docks

At Hamburg Antwerp Bremerhaven Glasgow London Manchester Havre and many other ports are found mechanical appliances each to meet the local requirements but all aiming to reduce the number of handlings and the cost of the same

In England at the freight stations and warehouses the practice is to install jib cranes so arranged that they can serve all the floor space from car or wagon.

In this country many of the railroads have put in hand cranes of the pillar or bridge type, for handling freight from cars to wagons, or vice versa, but they are mostly for heavy lifts, and are slow in operation and cover only a limited area.

Some of the railroads have put in electric cranes in their freight yards and water terminals, as for example, the Pennsylvania Railroad Company on its



From the *Illustrated London News*

THE ROUGH SKETCH OF BROOKLANDS ELABORATED AFTER REACHING THE GROUND

Mr Fleming Williams the artist writes Should a general be doubtful as to the best road to choose to reach a certain spot an aviator could, in a few minutes ascend and not only see the best way but sketch a map of it or write a report Should the position of an enemy be doubtful the aviator could easily locate tents or moving columns from a height and distance that would render him practically immune from gun fire

* Read before the Congress of Technology at the Fiftieth Anniversary of the granting of the Charter of the Massachusetts Institute of Technology

Greenville docks, the New York Central & Hudson River Railroad Company at Port Morris, the Philadelphia & Reading Railroad Company at Port Richmond, and the Central Railroad of New Jersey at Communipaw

Many of the railroads are coaling their locomotives at greatly reduced cost and time by mechanical appliances, but the question of handling their package freight at terminals is still open

Most managers have known that there is a great loss of time in transferring freight at terminal and intermediate points but few seem to realize the high costs that this involves

Perhaps the most complex movements in the handling of package freight are at the large steamship piers due to the great carrying capacity of the large vessels the many consignees each having his allotted space and the limited floor area that has to be cleared quickly to make room for the next vessel The larger railroad terminals also have their many consignees but the floor area is not so restricted

The placing of the packages in the proper space is done by the hand truck A sling load from the vessel or a railway car may contain packages for several consignees The truckman cannot wait to sort as he receives them so must load his truck with them as they come This means a long travel to get the packages to their alloted space In order to tier them several more handlings are necessary All this leads to congestion and increasing cost per ton

This is further effected by the rise in the cost of labor materials rent and larger terminals

Each terminal is a problem in itself as is each manufacturing establishment, so that it is necessary to make a careful study of the conditions to be met before any mechanical method can be proposed

In the last thirty years there has been a steady increase in the capital invested in manufactures which means an increase of tonnage of all kinds of package freight carried by the steamship and railroad companies To meet this the railroads have increased their rolling stock and either enlarged their terminals or built more In large cities this has been at great cost for land and buildings The method of handling the freight has remained the same

At a terminal there are two kinds of freight—out bound and inbound The outbound is transferred from wagons into the outbound freight house and thence to the railway cars or directly from the wagons to the cars

The inbound is *vice versa*

All the above movements except between wagons and cars involve the sorting and distributing of each package to its designated space It is also necessary to transfer cars from one freight house to the other as the use of the hand truck necessitates bringing the cars to the freight

A mechanical equipment to be satisfactory must be able to distribute the outbound and inbound freight simultaneously there should be no rehandling and every square foot of floor space should be served with a single handling

All motions of lifting and conveying should be done by power The machinery should be designed to give the greatest lift required and to transfer to any reasonable distance and then tier or lower into cars

Continuous operation should be sought for to avoid delay

No part of the transference should be along the floor and the equipment should not take up any floor space that can be used for other purposes

All movements of the mechanical equipment should allow of the assorting and distributing according to classification and allotted space readily and quickly

There must be reserve capacity to prevent congestion in case of extra demands

The justification for the investment of the mechanical installation lies in the reduction of cost and the saving of time in handling

The expense should be in proportion to the size of the terminal

There are many companies in this country engaged in the manufacture of hoisting and conveying machinery While perhaps no one makes all the necessary appliances yet a combination of their product could be used to fill the special requirements of each terminal point

Fully to cover the floor space and obtain all the different requirements for the satisfactory handling of the package freight three units or different types of conveying machinery are necessary These are the single rail electric trolley the bridge traveler and the cross traveler The electric trolley is the actual load carrying part of the equipment the single rail bridge traveler and cross traveler furnishing a combination of loop track system on which the trolley can reach any part of the area to be covered All movements should be so regulated that there will be no interference and many trolleys can be in operation following one another Each trolley can draw a number of trailer trolleys so that many packages can be hoisted and transported under the control of one man

This arrangement allows many loads to be transported in close sequence simultaneously and with maximum hoisting and traversing speeds gives the greatest range and capacity at a minimum of labor and maintenance

At some freight terminals it may be necessary to have in combination with the above mechanical conveyors motor trucks on the surface in others belt conveyors

There is no doubt that some such scheme as outlined above when properly carried out to meet the special requirements at any terminal would materially reduce the time and cost involved in the present method This has already been exemplified in the handling of bulk material

Considering the special attention now being given this question by several engineers and the interest shown by many steamship and railroad managers it can be safely stated that within the next few years great changes and developments will be accomplished

Electrical and Chemical Effect of Ultra-violet Rays

The Hertz Effect

Hertz discovered in 1887 that a polished metal plate charged with negative electricity was quickly discharged by the impact of ultra violet rays Almost all that is yet known concerning this remarkable photo-electric phenomenon which has been called the Hertz effect was soon discovered by Hertz and other skilful experimenters and no satisfying explanation of the phenomenon has been furnished by the numerous researches that have since been made

The Hertz effect is easily produced The spectrum of an electric arc is thrown by means of a slit *S* a quartz lens *L* and a quartz prism *P* upon a polished plate of metal *M* which has been substituted for the ball of a gold leaf electroscope *E* and has been charged negatively so that the leaves *ff* diverge widely Any desired portion of the spectrum can thus be allowed to fall on the metal plate the remainder being cut off by screens attached to the electroscope The electrical condition of the plate is not affected by the rays of the visible spectrum but the gold leaves rapidly fall showing loss of electric charge when ultra violet rays strike the plate No similar effect is produced when the plate is positively electrified

Hertz was led to the discovery of this curious effect by observing that the discharge between the polished metal balls of an electrical apparatus with which he was working was facilitated by the production of electric sparks in their vicinity It would be interesting but it would require too much space says a writer in *La Nature* to follow the long course of experiment and deduction by which Hertz successively eliminated every other possible cause and finally traced the last mentioned phenomenon to the influence of the ultra violet rays emitted by the spark

The Hertz effect cannot be reproduced indefinitely with the same plate without repolishing After a time the ultra violet rays fail to dissipate the negative electric charge The metal is then said to be fatigued but its sensitiveness to ultra violet rays can be restored by polishing it with emery paper Various ingenious explanations of this mysterious phenomenon of photo-electric fatigue have been given but none of them is satisfactory The different metals vary considerably in their photo-electric properties. Zinc and aluminium exhibit the Hertz effect very strongly, while copper and silver are much less sensitive to ultra-violet rays In general the photo electric order of the metals agrees closely with the electro-chemical order, the most strongly electro-positive metals being the most sensitive to ultra violet radiation.

The chemical effects of ultra violet rays have, until recently been observed only incidentally in connection with other researches In this way an apparent formation of ozone in air and of hydrogen peroxide in water was noted but even these simple effects have

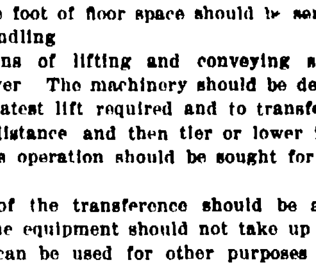


Fig 1—ARRANGEMENT OF APPARATUS FOR PRODUCING THE HERTZ EFFECT

been the subject of controversy Last year some direct experiments were made which appear to prove that ultra violet rays possess great chemical powers By their agency Berthelot and Gaudechon have transformed cyanogen into paracyanogen and oxygen into ozone polymerized acetylene and ethylene converted a mixture of ammonia and oxygen into nitrogen and water and oxidized acetylene to carbon monoxide carbon dioxide and formic acid

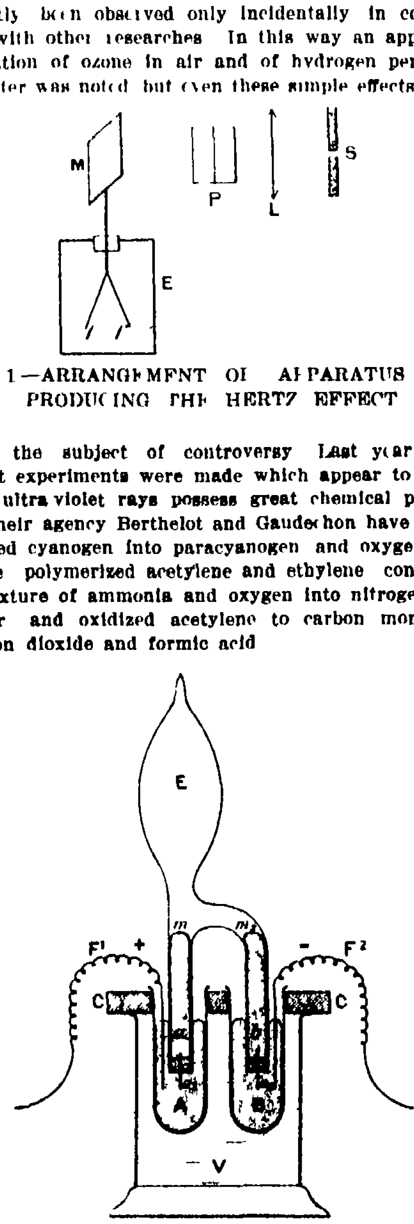


Fig 2—PEROT MERCURY VAPOR LAMP

The ultra violet rays are still enveloped in mystery and many years may elapse before their effects are thoroughly known and explained Researches in this field promise to contribute much toward the formation of a satisfactory theory of the constitution of matter which is one of the most audacious enterprises of modern science

Ultra violet rays are produced by the electric arc and their intensity is increased by employing carbons with zinc or aluminium cores In experiments which require the isolation of the source from the surrounding medium a mercury vapor lamp should be employed Prof Pérot has devised a lamp of this type which is easily managed of small dimensions and much less expensive than the lamps generally employed The quartz vessel (Fig 2) in which the light is generated has the general shape of the small letter h consisting of two vertical tubes *a b* and an olive-shaped bulb *F* placed directly over the tube *a* The tubes are filled to the level with mercury and stand in two wide open mouthed glass tubes *AB* which also contain mercury Electrical connection between the mercury in the inner and outer tubes is maintained by two platinum wires *e* which traverse the closed ends of the quartz tubes The mercury in the glass tubes *AB* is connected with a source of current by the wires *F F* the tube *A* being connected to the positive pole The glass tubes are suspended from the cover *CC* of a vessel *V* which is filled with water for the purpose of preventing overheating When the circuit is closed an arc forms spontaneously between the anode meniscus *m* and the cathode meniscus *m* The tendency of particles of mercury to travel with the current from the anode to the cathode is counteracted in the Pérot lamp by the fact that all of the mercury which rises as vapor from both tubes and is condensed on the walls of the bulb *F* falls back into the anode tube *a* Experience shows that the mercury remains constantly at the same level in both tubes with a current of 10 volts and 2 or 3 amperes In these conditions the lamp furnishes a perfectly steady constant light

A 60 watt tungsten filament lamp will illuminate very satisfactorily a fairly large room yet its filament if crushed to powder would make a cube of less than one-twentieth of an inch on each side Nevertheless few substances are subjected to such severe treatment as the bit of matter that composes the filament of an incandescent lamp and the number of materials which can be used for that purpose is consequently very limited

The German Antarctic Expedition

Its Personnel and Its Equipment

The German Antarctic Expedition will start in the early part of May 1911 Its principal object is to explore the interior of the Antarctic Continent and to establish a connection between its eastern and western parts The expedition will proceed from Hamburg to Buenos Aires and thence to the island of South Georgia where it will refill its bunkers from a store of coal which has been sent ahead after which it will push on southward to Weddell Sea It is the intention to search for Coats Land discovered by Bruce in 1904 on the eastern side of Weddell Sea, to follow the coast as far southward as possible and establish a base and scientific station which will be maintained for at least one year and will serve as the point of departure for expeditions by sledge into the interior For this purpose a detachment of eleven or twelve men has been specially assigned

A detailed account of the scientific program of the expedition is given in a memorial circular from which we quote the following information as reproduced in *Illustrirte Zeitung* The honorary chief of the expedition is the venerable Prince Regent Luitpold of Bavaria. The personel consists of thirty five men The actual leader of the expedition is Dr Wilhelm Filchner a Bavarian officer well known through his explorations in China and Tibet who has been assigned to the command of the expedition by the Prussian General Staff The second in command is Dr Seelheim the geographer of the expedition The meteorological observations will be conducted by Dr Barkow of the Royal Meteorological Institute at Potsdam the oceanographer is Dr Brennecke of the Hamburg Naval Observatory who occupied the same position in the Planet Expedition to the South Sea the geological work is in the hands of Dr Heim of Heidelberg and the physicians are Dr Kohl of Munich and Dr Wachter of Vienna both of whom are trained alpinists and snow shoe experts Dr Felix Koenig has been added to the party because of his expert knowledge of sledging Prof Lohmann will accompany the expedition from Kiel to Buenos Aires as biologist. The astronomical and magnetic observations will be conducted by Dr Przybyllok of the Potsdam Geodetic Institute Herr Neuberger an expert automobile machinist will look after the motor vehicles The nautical command is in the hands of Capt Vahsel of the Hamburg-American Line who was second officer of the Gauss" in the first German Antarctic Expedition and who commanded the Pelho in the recent German South Sea Expedition. The first officer is Herr Lorenzen who occupied the same position on the Pelho The second officer is Herr Mueller of the North German Lloyd who has long been navigator on the cable steamer Stephan The third officer Herr Slosarczyk, has prepared himself for his work as wireless operator of the expedition by similar work on the transatlantic liner Patricia

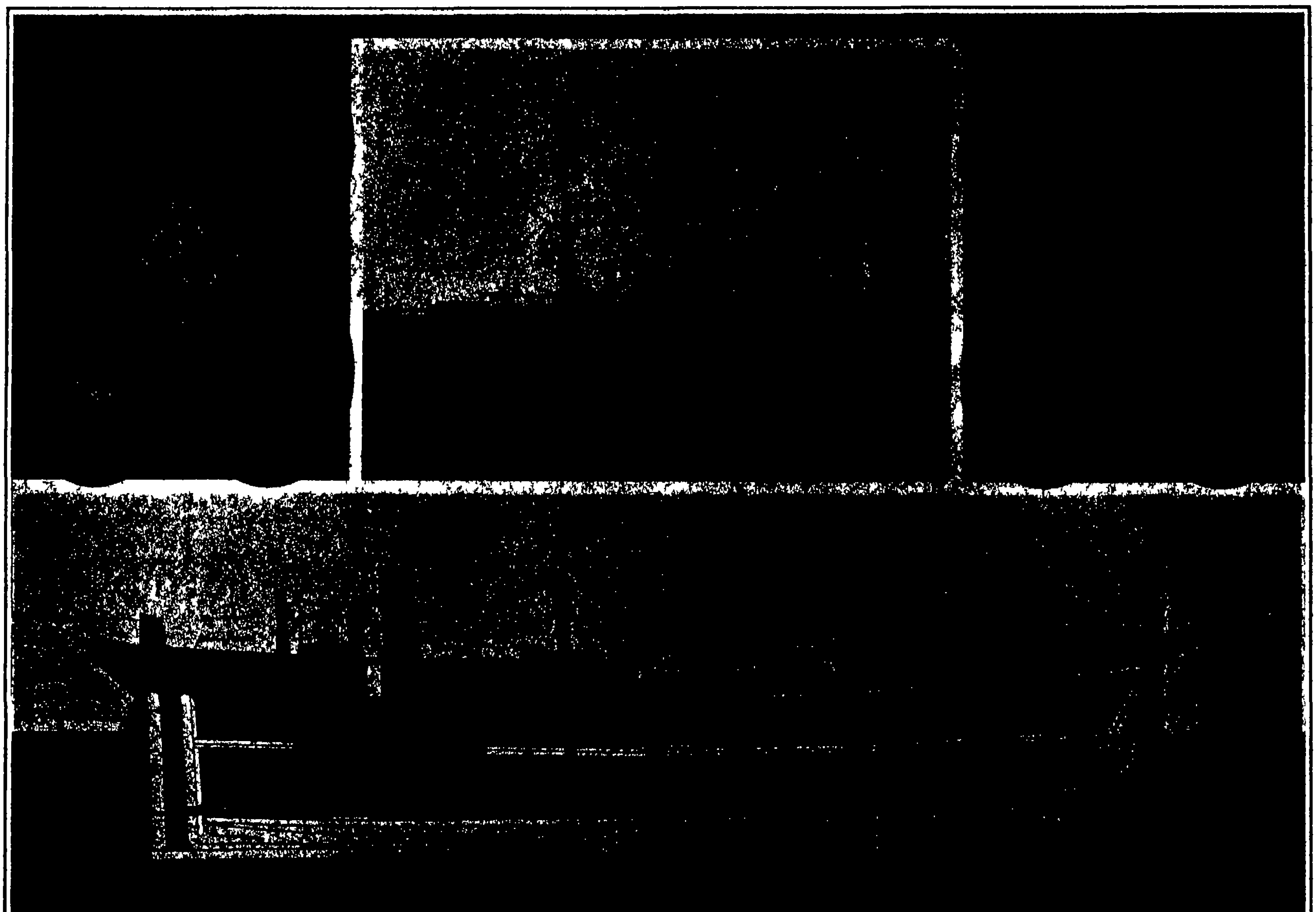
The chief engineer is Herr Heyneck of the Hamburg American Line Several of the best men of the Gauss expedition have been secured including the cook Klick the carpenter and diver Heinrich the steward Besenbrock and the preparator Noack.

The outfitting of the expedition falls naturally into three parts the ship the provisioning and the means of land transport. All the experience accumulated in former polar expeditions has been utilized in the preparations and Dr Filchner made a special expedition from Spitzbergen last year in which he accumulated much valuable experience and formed the acquaintance of several scientific men of the expedition who accompanied him

The expedition is provisioned for three and one-half years and carries more than 200 tons of food stuffs Automobiles of peculiar construction which have been very successfully employed for drawing sledges in extensive experiments in Norway and the Bavarian mountains will be carried for that purpose. Capt. Scott will employ similar vehicles in the English Antarctic Expedition which is now fitting out. In addition dogs will be carried and also ponies which Shackleton found very useful for drawing sledges The sledges carried by the expedition are of the type used so successfully by Nansen Most of them are about ten feet long, two feet wide and very low The dogs were obtained from Greenland, the ponies from Eastern Asia.

The ship, the "Deutschland" was purchased in Norway last autumn It is a whaler and has proved its staunchness in ice It was built in 1905 of spruce, oak and pitch pine, with ice breakers and an ice shield of "greenheart." It is bark rigged, and has an auxiliary engine of 300 horse-power which, with favorable weather and a daily consumption of five tons of coal can drive it at the rate of seven knots, Under sail the ship can make nine or ten knots with a favoring wind. The gross tonnage capacity was originally 527 tons but alterations have been made which increase the capacity by more than 100 tons. The ready-built houses, sledges and building timber will be stowed on deck on leaving Buenos Aires. The cabins for the officers, scientists cook and steward, the kitchen and pantry and a large and a small saloon are located in a well protected deck house occupying the after half of the ship Each officer and scientist has a separate cabin. On the forward deck is a large laboratory flanked on each side by stalls for ten ponies Between decks are the men s quarters and lavatory The dogs are quartered under the forward deck The ship has been equipped with an electric plant, and all its parts will be lighted by electricity except in case of a shortage of coal. The dynamo will also serve to operate the wireless transmitter Two tanks of 11 tons capacity and two of ¾ ton capacity will contain the supply of drinking and boiler water The vessel is provided with a device for raising the propeller Three propellers are carried two of nickel steel and one of iron The boats include two whale boats, two large lifeboats and a seven-horse-power motor boat.

The total cost of the expedition is estimated at $350,000 To defray this cost the governments of most of the German States have authorized lotteries, the guaranteed net proceeds of which will be about $200 000. Large subscriptions have also been received from various persons Nevertheless, additional funds are required to carry out the expedition to success, and it is to be hoped that the appeal issued by the committee will meet with a generous response.



From the Illustrirte Zeitung

PHOTOGRAPH AND LONGITUDINAL SECTION OF THE DEUTSCHLAND AND PORTRAITS OF THE LEADING MEMBERS OF THE GERMAN ANTARTIC EXPEDITION

1 Dr Filchner 2 Dr Seelheim 3 Dr Barkow 4 Dr Kohl 5 Dr Koenig 6 Dr Przybyllok 7 E. Heyneck 8, K Neuberger

A Modern X-Ray Laboratory

The Interrupter or "Break"

By Reginald Morton, M D

ONE of the most important elements in the modern X-ray equipment is the interrupter or break" as it is generally called As its name indicates its function is to interrupt or break the flow of current through the primary coil of the inductorium A sudden interruption is essential for the working of the coil, and the more sudden and complete it is the

FIG 1 AN X RAY CABLE TESTING OUTFIT

better is the discharge from the coil. A review of some of the principal types of 'breaks" in use at the present day is given by Reginald Morton M D

Up to the time of Roentgen s discovery breaks were of a simple and not very efficient form they were only used in circuit with batteries of low voltage and as the induction coils were as a rule small in size and giving short spark length they answered well enough

The demand for greater discharges to excite heavier and stronger tubes soon made it evident that the interrupter would have to be modified especially as it was desired to make use of the comparatively high pressure currents from the street mains The platinum hammer break (see Fig 2) was one of the first, and though it is seldom used now for heavy work and mostly on portable apparatus in its most modern form it can be made to give very good results It requires care in adjustment and manipulation but is practically the only kind that can be used in military service in the field

A disadvantage of this form is the flashing that takes place between the platinum points every time the current is broken this is troublesome when it is desired to make use of the fluorescent screen in a dark room

It was found that when the break was so modified that one of the points was replaced by a dish of mercury the spark from the coil was intensified In one of the earliest types a copper wire was made to dip in and out of the mercury by the action of a small electric motor and a number of interrupters

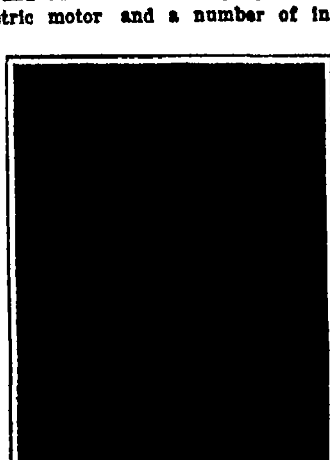


FIG 2 A PLATINUM BREAK

of this kind are in use, for X ray treatment especially (see Fig. 4)

Following on this we have the mercury jet breaks which were a great improvement in that they gave a much higher rate of interruption for the same quality of discharge from the coil. In these a small jet of mercury is made to impinge upon a copper blade or blades. It is immaterial whether the jet revolves or whether the copper teeth revolve around the jet, the result is the same. The mechanism is inclosed in a glass or iron vessel which contains a quantity of mercury at the bottom and is then filled up with spirit or paraffin oil The break thus taking place under the surface of the fluid is all the more sudden and complete and this type of mercury break has been, and is very popular The great disadvantage is the large quantity of mercury required (20 to 30 pounds in some) and the rapidity with which the latter becomes emulsified and useless for the time being Most of the mercury can be recovered but the process is very messy (See Fig 3)

Owing to this difficulty of cleaning efforts were made to find some gaseous medium to replace the liquid in common use and it was found that ordinary house gas was all that could be desired It may be said that any mercury break designed for the use of liquid will work equally well or even better if the gas is used instead The case has of course to be made tightly fitting so as not to allow free escape of the gas Used in this way the mercury does not become emulsified only a small quantity is required and the small amount of black mercury compound that gradually forms need only be removed at long intervals.

The most recent development of the mercury break is a more or less radical departure from the jet type we have been considering but the change is a very important one and the system upon which they work is one that is likely to prevail The principle involved is an old one though its application to interrupters is quite new It is well known that if we fill a hollow sphere with liquids of different densities and then

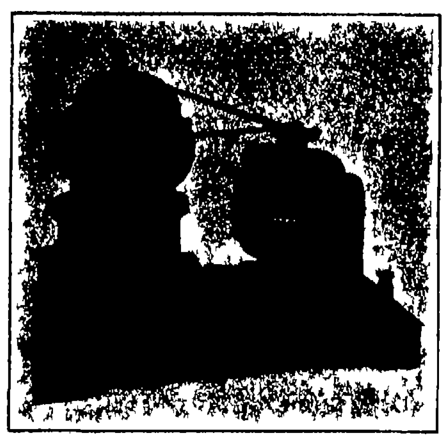


FIG 3 A JET BREAK

rotate the sphere rapidly the various liquids will tend to arrange themselves around the equator of the sphere with the heaviest liquid against the wall and the lightest liquid nearest the center of rotation Applying this principle to an interrupter the hollow space is flattened at the poles and the equator is bulged out This form is found to give the best results, as might be supposed (See Fig 5) Into this jar is placed some mercury and paraffin oil and the whole is mounted upon the end of the shaft of an electric motor which is placed vertically As the latter is set in motion the jar turns with it and the mercury by virtue of its greater weight at once takes up its position at the widest part Its rate of rotation is a little less than that of the jar which is made of cast iron both for its strength and its resistance to the action of mercury There are several forms of interrupter working on this principle but the above arrangement forms the basis of them all In one of them a fiber disk with a metal segment and about the size of a five-shilling piece, is mounted so that its edge engages the whirling band of mercury This causes the disk to rotate rapidly and as the metal segment touches the mercury the circuit is completed to be suddenly and completely broken when it leaves

When we consider the remarkable property of the X rays in readily passing through substances that are quite opaque to ordinary light it would seem that they ought to be of the greatest use under many and diverse conditions In the early days of their discovery many extravagant predictions were made as to their probable value and these were treated more or less seriously As a matter of fact if we take away their application in medical and surgical work so little remains that the demand for the necessary apparatus would be too small to be worthy of the serious attention of any manufacturer except in the fulfillment of a special order

It will be thus easily understood how difficult it is, when treating of the uses of the X rays to avoid reference to medical matters Their limited use in other directions is due to several causes and the chief one is that the X ray image is a silhouette and not a photograph as it is sometimes erroneously termed The property of arresting the passage of

FIG 4 A DIPPER BREAK

the X rays and thus casting a shadow is purely a question of the atomic weight of the elements that make up any substance Speaking generally substances of vegetable and animal origin except the bones are very transparent With the exception of aluminium all the metals in common use are more or less uniformly opaque Calcium having an intermediate atomic weight is semi transparent, and as lime salts enter very largely into the structure of most living organisms the X rays are very valuable in studying their normal structure as well as tracing departures from the normal, whether from disease or accident Any inequalities in thickness are registered on the screen or plate and so accurately is this done under favorable conditions that the details of structure can often be made out a good radiograph of the hand or foot shows this very well

Some very interesting discoveries have been made in this way regarding the internal structure of shells and the rays have been used in examining oysters for the presence of pearls If no pearls are present the oyster is returned to the sea which is presumably an advantage to the oyster In a like manner electrical cables are examined (see Fig 1) both for the continuity of the conductor and to see that it maintains its proper relation to the other members of the system The modern electric cable is in many instances a very highly specialized structure that has to stand very severe strains both mechanical and electrical and as an apparently small fault may give rise to very serious trouble the final inspection has to be carried out with the greatest care before it is passed as fit for service

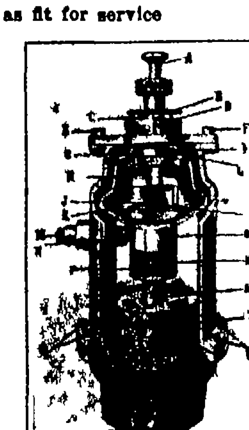


FIG 5 SECTION THROUGH ROTATING DISK BREAK

With regard to the medical and surgical uses of the X rays most people are inclined to think that the examination of fractures and the detection of foreign bodies within the human organism constitute the main field of their usefulness These are of course very important applications and ones that count for much in hospital practice particularly but they do not by any means constitute the whole An ordinary simple fracture occurring in the shaft of a long bone such as in the middle of the upper arm

can be dealt with quite satisfactorily, whether examined by the X rays or not but the surgeon who attempts to deal with a fracture close to or involving a joint without having it properly examined by this method takes a risk to his patient as well as to his own reputation that is not justifiable In an instance of this kind an injured wrist was declared to be a severe sprain and treated as such Fortunately the patient decided to come to the hospital where it was X rayed as a matter of routine This showed that the bone was not only broken in at least three fragments but that one of the lines of fracture entered the wrist joint The fact that there was no displacement of the fragments led to the erroneous diagnosis being made and had this been treated in the ordinary way a stiff wrist joint would have resulted almost certainly

In the early days of the X rays their use was almost entirely confined to strictly surgical cases nowadays the method is used almost as much for the investigation of medical cases such as disease of the respiratory organs the heart and great blood vessels tumors and obstructions in the digestive system The last mentioned application is a comparatively recent development and one of great interest The method consists of giving jelly or other food containing a large amount of a bismuth compound which is quite harmless The bismuth being opaque to the X rays the progress of the food can be watched in its advance along the digestive canal and at times the information gained is very valuable There is a great danger however in misinterpreting the appearances because similar shadows may be made by very different conditions In no instance is the opinion of an expert more necessary than in this

By means of very powerful apparatus more or less instantaneous radiographs can be made of the heart when the X ray tube is placed no less than two meters from the plate Owing to the great distance of the tube the size of the shadow of the heart is very nearly the same as that of the heart itself and it is the best method at our disposal for accurately determining the dimensions of that organ Changes in these dimensions can be detected by making examinations at intervals This by no means exhausts the list of applications of the X rays in the diagnosis of disorders of mankind but enough has been said to show how much progress has been made and the science is by no means at a standstill Improvements in methods and in personal skill are being introduced every day and scarcely a month passes that does not give us something new in the way of improved appliances

It was comparatively soon after the discovery of the X rays that some investigators began to employ the radiation for purposes of treatment They were led to do this from the good results that were being obtained with the ultra-violet rays, and from the fact that many X ray workers had begun to suffer from a form of dermatitis which was rightly attributed to the influence of the X rays themselves It was at this stage that the foundations were laid for the immense amount of suffering that has been endured by many of the pioneers of X ray work, many of whom still continue to suffer in one way or other in spite of the fact that they have taken every possible precaution since the first attack of the dermatitis. The danger from these rays is only incurred by those who are working with them more or less continuously there is not the slightest danger to any one who undergoes an examination or a course of treatment by the X rays so long as the work is done by one who is a recognized expert in such matters

It may be taken as an axiom that any agent that is capable of doing so much harm as this can also be made to do a great deal of good if only its powers are properly controlled and directed into the right channels The great trouble in administering thes rays therapeutically was that of knowing how large or how small a dose was being given and even at the present time the methods at our disposal are not anything like so simple and scientific as that of giving ordinary drugs We have no satisfactory method of ascertaining the exact strength of radiation the patient is getting at any given moment our methods will only tell us how much has been given and that rather crudely The means mostly employed are sufficiently accurate in the hands of one who has had a considerable experience of the work and who has become more or less familiar with the vagaries of the X ray tube The day is not yet that the novice can dip into this work without running considerable risk

When the platino-cyanide of barium is exposed for a certain time to the influence of the X rays it turns from its usual greenish yellow tint to that of a light orange This material is spread upon stiff paper and cut into small circular pastilles The X ray tube is inclosed in a ray proof shield from which the rays can escape only by an opening made for the purpose the size and shape of which can be altered to suit any ordinary conditions The pastille is held in a clip exactly half the distance between the source of the rays and the area to be treated and is so arranged that it can be removed for examination from time to time With each set of pastilles is supplies a standard tint to which the pastille must change before the ordinary full dose is given This is in outline the method in use at the present time by the majority of radiologists It is admittedly a crude one when judged by other standards of measurement but in the hands of the expert it gives very good results.

With regard to the conditions that are benefited by this form of treatment, it may be said that the more superficial is the disorder the more likely is it to be favorably influenced, this is only another way of saying that the method finds its greatest field of usefulness in the treatment of the diseases of the skin, and the results that have been obtained are at times quite remarkable It is a very fortunate thing that it is among those conditions that are, as a rule very resistent to all ordinary methods of treatment, that some of the greatest successes have been made

Before closing this article it may be of interest to indulge in a little speculation as regards future developments While we have seen that improvements in the electrical appliances have been going on from the very beginning and show little sign of any falling off in this gradual but steady improvement the X ray tube itself has undergone no radical change since the invention of the focus tube by Prof Herbert Jackson

It is quite true that the X ray tube of the present day is a great improvement on the original Jackson tube It is larger in size more steady in action and more capable of withstanding the various and severe stresses to which it is subjected and is also provided with a means of regulating its vacuum but it remains in principle as it always was and great as its improvement has been it has not kept pace with the development of the electrical side of the X ray equipment Any modern coil can completely wreck any X ray tube in a few seconds if desired Our greatest want now is a tube that is steady in action and in vacuum that will give out a certain quality of radiation as required and continue to give this no matter how great power is applied to it within the limit of reasonable requirements With a view of meeting some of the conditions it has been suggested to make the bulbs of quartz instead of glass but so far no one seems to have attacked the problem seriously Quartz is much more transparent to the X rays than any form of glass it is independent of any changes of temperature and will stand any amount of rough usage within reasonable limits It certainly should be well worth giving a thorough trial if only for the advantages already mentioned But even with these advantages it could not be said that the X ray tube was in the nature of a perfectly satisfactory instrument In the present state of our knowledge it is very difficult to see how the X ray tube can be radically improved upon We can only wait patiently, and for all we know some means of getting our X rays may be discovered that is much more simple and reliable and entirely different from the methods we use at present

The Past and Present Geographical Distribution of the Iron Industry of the United States

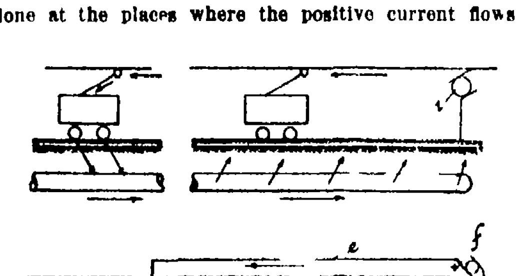
In his address on Geology and Economics speaking before the New York Academy of Sciences Prof J A Kemp referred as follows to the geographical distribution of iron producing centers and the changes which have taken place in their relative importance

The iron industry in the United States took its rise in the colonies along the Atlantic seaboard—and at the outset was based upon the magnetic ores and brown hematites there occurring For one hundred and fifty years its growth was slow In the decade of the forties and fifties of the past century it had spread to the Adirondacks and in the fifties began its development in the Lake Superior region Not until after the close of the civil war and the resumption of peaceful activities did this great industry manifest its possibilities With improved facilities of navigation which placed Lake Superior in easy communication with the coal producing States of Pennsylvania and Ohio the iron-ore producing States of Michigan Wisconsin and later Minnesota, came rapidly into prominence In somewhat slower growth Alabama during the seventies and eighties gathered headway At present four fifths of our ore supply comes from the three Lake Superior States and three out of the four fifths from Minnesota alone Alabama Tennessee and Georgia together yield one tenth and the remaining tenth is divided among a dozen or more other States of which New York is the leader Since 1880 the total has increased about seven fold and Pennsylvania then the source of about one quarter the supply now yields approximately one and one half per cent Minnesota, now the great source of ore only entered the lists in 1884 and only began to utilize its present great mines about ten years later

Thus in the brief course of thirty years there have been very great rearrangements not only in geographical sources of supply but still more in actual amount of output. In normal prosperous years the annual production is somewhat more than fifty million tons of ore."

Protection of Underground Pipes from Electric Currents

Gas pipes and water pipes laid near electric rail way tracks are frequently corroded by the action of stray earth currents If the parts attacked are protected by a coat of tar the mischief is simply shifted to the adjacent unprotected portions The damage is done at the places where the positive current flows



PROTECTION OF UNDERGROUND PIPES FROM ELECTRIC CURRENTS

from the pipe to the earth because here oxygen is set free while in places where the positive current flows from the earth to the pipe the metal is protected by an evolution of hydrogen The arrows in the upper diagram of the accompanying illustration show the course of the current generated by the dynamo *e* flowing through an overhead trolley wire and a number of cars to the rails and leaking to the water pipe beneath The pipe is corroded only in the right hand portion where the positive current flows out of it According to a note in *Prometheus* a German railway manager has succeeded in protecting such pipes by superimposing on the injurious current, a current flowing in the opposite direction

The lower diagram shows how this result is accomplished A second overhead wire *c* is stretched parallel to the trolley wire and is supplied by the dynamo *f* with a current flowing in the same direction as the working current The distant end of this wire is connected with a return wire *d* which is buried near the pipe and rails The negative pole of the dynamo however is connected not with the return wire but with the pipe Hence positive current flows from the return wire *d* through the earth to the right hand part of the pipe neutralizing the injurious current flowing from the pipe to the rails This device has given satisfactory results during fifteen months service

Waterproofing Fabrics

The French army is interested in a new method for waterproofing fabrics which is claimed to be superior to usual processes English manufacturers have been in the lead in bringing out waterproof fabrics for many years past Besides rubber for fabrics, we have the use of insoluble gelatine boiled linseed oil shellac metallic soaps and others, which have had more or less success It appears that the best product for waterproofing is acetate of aluminum, and when applied to the fabric it can be made to form alumina in a gelatinous state and volatile acetic acid When such fabric is dried it is waterproof, but has not the objectionable feature of rubber and other material as it allows the air to circulate through it The fabric is also quite supple, and this is especially necessary so that clothing can be made of it. As the French army department is looking for the best method of waterproofing which can be used for military cloaks as well as for tents some experiments were made, and it was found that the above process is the best, according to the opinion of the best authorities This is especially true now that acetate of alumina solution can be found on the market and does not need to be prepared specially M Balland recommends a bath of one part acetate (7 deg B) and forty parts water Fabrics are soaked in it for twenty four hours, and are then dried in the air This method is being used in the army headquarters at present.

Fire and Burglar-Proof Safes.—I.*

Recent Advances in the Construction

By E. E. Watson

In order to place before you the recent advances in the construction of fire and burglar proof safes, it is necessary to cover a brief history of the industry from its actual beginning in the early part of the nineteenth century down to the present time.

Practically speaking, the more recent advances have had to do principally with refinements in mechanical processes, the development of factory organization and the perfection of elements of design that were conceived long before the means were at hand for their proper realization.

The development of any industry is in a large measure dependent upon the activity in other related industries, and the progress in the one must mean a general forward movement on the part of all.

The development of the art of building safes for the protection of valuables is interwoven so closely with that of the art of lock building that the two subjects necessarily must be treated together.

It is a fact that is apparent to anyone who gives consideration to the subject, that a safe, however secure from the standpoint of construction, would be useless without an opening giving free access to its interior and that opening guarded by a lock at least as secure in point of design and construction as the safe itself.

The conclusion must be drawn from this that safe building in point of relative security could only keep pace with the development and with the design and construction of locks. The history, therefore, of the development of the safe building art is in reality first the history of the development of locks.

Locks as we know them to-day and as they have been known ever since they were first used consist primarily of a bolt and a key for operating the bolt and some means interposed between the key and the bolt to render the operation of the bolt either more or less difficult or impossible without the use of the proper key.

The means employed for housing the working mechanism of the lock and for applying it to the protected structure are of little importance in this consideration. All of the different locks possess these features. They may be divided into several general classes.

First, not only in point of simplicity, but naturally also in point of historical origin, is the latch lock, in which there is a bolt pivoted on a fixed point and raised by some sort of a key.

Locks were later rendered more secure by the introduction of the warded type, in which the introduction of the key into the hole provided for it was rendered more or less difficult by means of interposed wards, making it, to a degree at least, impossible to introduce the wrong key.

The warded type of lock was succeeded by the present day lever tumbler type, in which tumblers are interposed between the key and the bolt, making it necessary for the key to lift the different tumblers before the bolt can be withdrawn. This type of lock is considered secure in proportion to the number of tumblers used and the means provided for varying the relative amount of lift.

The bolt of this type of lock has fitted to it a member that passes into slots in the lever tumblers in the operation of its withdrawal, and the province of the key is to line up these slots in the lever tumblers so that they register with the fixed member on the bolt.

A later development of the tumbler type of lock is that known as the cylinder pin tumbler lock. In this type of lock the obstruction consists of divided pins preventing the turning of the plug until these pins have been raised to a point where the division line between the different sets of pins coincides with the outer surface of the plug and the inner surface of the cylinder, in which it rotates. When these points have been so lined up by the introduction of the proper key the cylinder may be rotated and the bolt withdrawn.

The inconvenience resulting from the use of the ordinary type of key lock, by reason of the fact that keys could be wrongfully duplicated, or they might in various ways come into the possession of persons not entitled to them, gave the necessary impetus to inventive genius, and the modern dial or combination lock was the result.

Coincident with the development of the dial lock is that of the changeable type of key lock, in which the arrangement of the tumblers or obstacles may be almost indefinitely varied. It practically after being set up to a new key becomes an entirely new lock and cannot be operated by any other key than that to which it is set up.

The development of the changeable-key type of lock is of great importance for the reason that a limited amount of security is frequently needed of a kind that cannot be afforded by the ordinary type of lock. This security is frequently furnished by combination or dial locks that are much more expensive.

The changeable key locks until recently have been of a design and construction that were very apt to get out of order and cause considerable inconvenience to the user.

Many efforts have been made to produce a simple lock of the changeable key type, all of them depending upon the introduction of a double tumbler between the key and the bolt. The changeable key lock that is being manufactured by the Herring-Hall-Marvin Safe Co. is the only one in which the obstacle that is interposed consists of a single member. The tumbler of this lock departs from the lever tumbler type previously employed in that it has no fixed pivot, but can be properly called a balanced tumbler.

Its greatest merit is its simplicity and its substantial construction. In all other types of changeable-key locks the means provided for changing the combination are delicate, and in the ordinary operation of the lock the wear on these delicate parts is constant. In this lock the means provided for changing the combination are not in the least delicate, and the ordinary operation of the lock in opening and closing after it has been set up to a key causes absolutely no wear on the combination part of the tumbler, making the lock just as substantial and as little liable to get out of order as the simple lever tumbler type of lock.

It is generally conceded by those who are interested in the manufacture and sale of locks that the changeable key type of lock has been greatly limited in its use heretofore by reason of its delicacy and its propensity for getting out of order.

As an evidence of the simplicity of the Herring-Hall-Marvin Safe Co. lock, it is necessary only to call attention to the fact that in this lock, which admits of over 59,000 different changes, there are but 14 parts, while in the highest type of changeable key lock previously invented, which afforded but about 8,000 changes, there were over 40 parts.

Its application, while not exactly universal, is broad enough to enable it almost entirely to supplant the other types of key locks.

In the case of apartment houses, where tenants are constantly changing, the ordinary type of lock affords absolutely no security, for the reason that keys may be duplicated. With the changeable key type of lock it requires but an instant of time to set up the lock to a new key and thereby render all previous keys inoperative.

The combination lock, as it is known to-day to distinguish it from the key lock, became a necessity when it had been demonstrated that practically all key locks could be picked. This fact was developed in the historic lock controversy of 1851 in England, when Mr. Hobbs succeeded in picking all of the best makes of locks.

A few years later, in 1856, Mr. Linus Yale, Jr., succeeded in picking several of the Hobbs locks. It then became generally conceded that no difference what the obstacles were that were interposed between the key and the bolt, so long as an opening was left for the insertion of the key, this same opening provided means for the insertion of picks to raise the tumblers. Mr. Yale then turned his attention to the designing of a lock that could be operated in some manner other than by the insertion of a key, and the early type of combination lock was the result.

The combination lock being in such general use today needs no lengthy description. It consists of the tumblers, the bolt, a lever member interposed between the tumblers and the bolt, and a spindle or arbor having on its inner end a driving tumbler and on its outer end a dial. The lever member, usually characterized as a fence, is from the standpoint of security a very important part of the combination lock.

The first locks were fitted with a gravity fence, and it was later found that the disk tumblers could be rotated so as to bring their notches in line with the fence even when the combination was unknown. The fence rested upon the periphery of the disks, and could with patience and a delicate sense of touch be felt into the notches one at a time until all of the disks were lined up, when the bolt could be retracted by simply turning the dial. This defect was a serious one. It was finally overcome by Mr. Emory Stockwell, of the Yale Bank Lock Department, by the invention in 1884 of the balanced fence. This fence was so supported that it brought no weight to bear upon the periphery of the tumblers. It was fitted with a friction bearing and could be moved out of its neutral balanced position only when the tumblers or disks had all been lined up in registry with it.

This improvement rendered the combination lock absolutely unpickable. It however remained for the ingenuity of the burglar to devise ways and means for defeating even this supposedly perfect lock. It was evolved out of the fertile brain of some enemy to organized society that a mental key always existed, and could be secured by torture—the combination numbers were always known by some one. There began in the year 1874 a series of bank robberies all over the United States, the most important of which were carried to a successful termination by reason of this one weakness of the combination lock.

It immediately became evident that a lock with absolutely no communication with the outside of the protected structure was necessary and essential to security, and the invention of the time lock followed. This was and still is to a large extent used in connection with the combination lock. Its use prevents the operation of the combination lock until such time as the time lock has run down, and by so doing withdrawn its obstruction to the operation of the combination locks themselves or the means provided for opening.

Meanwhile, in an entirely different field, inventive genius had been equally active by the invention of liquid high explosives, the fluidity of which could be increased by the addition of liquefied ether, so that it could be made to flow into the space surrounding the lock spindles or into the joint between the door and the frame. The burglar, without first securing any proprietary rights in the invention, adopted this method, and the battle of wits began over again, with the result that the lock makers finally evolved a motor device working in conjunction with a time lock, which made it unnecessary to connect the outside of the door with the inside by means of spindles. The motor after being set would throw the bolts when the door was seated into the jambs, and would instantly retract them when tripped by the running down of the time lock.

The motor device has not been universally adopted for several reasons, mainly because spindles can be and are made so that they cannot be driven in or pulled out, and they can be and are made drill-proof. They are ground into the doors so closely that no liquid can be forced around them.

In concluding that part of this paper which relates to locks, I desire to call attention to the fact that while practically all types of key locks can be picked, it does not follow that the key lock should be discarded, for the reason that the measure of security afforded by the lock need not be greater than that afforded by the protected structure itself. Manifestly a light wooden door affords very little security, yet millions of them are fitted with locks. Some with the common warded type, others with the lever and pin tumbler types—all at least affording a measure of security equal to that of the protected structure itself.

That these locks can be picked is no argument against their use, because entrance could be had in nearly all cases in an easier way. The inherent defect in all key locks other than the changeable key type lies in the facility with which keys may be wrongfully duplicated and used, rendering such locks of no security whatever.

(To be continued.)

* Journal of the Franklin Institute.

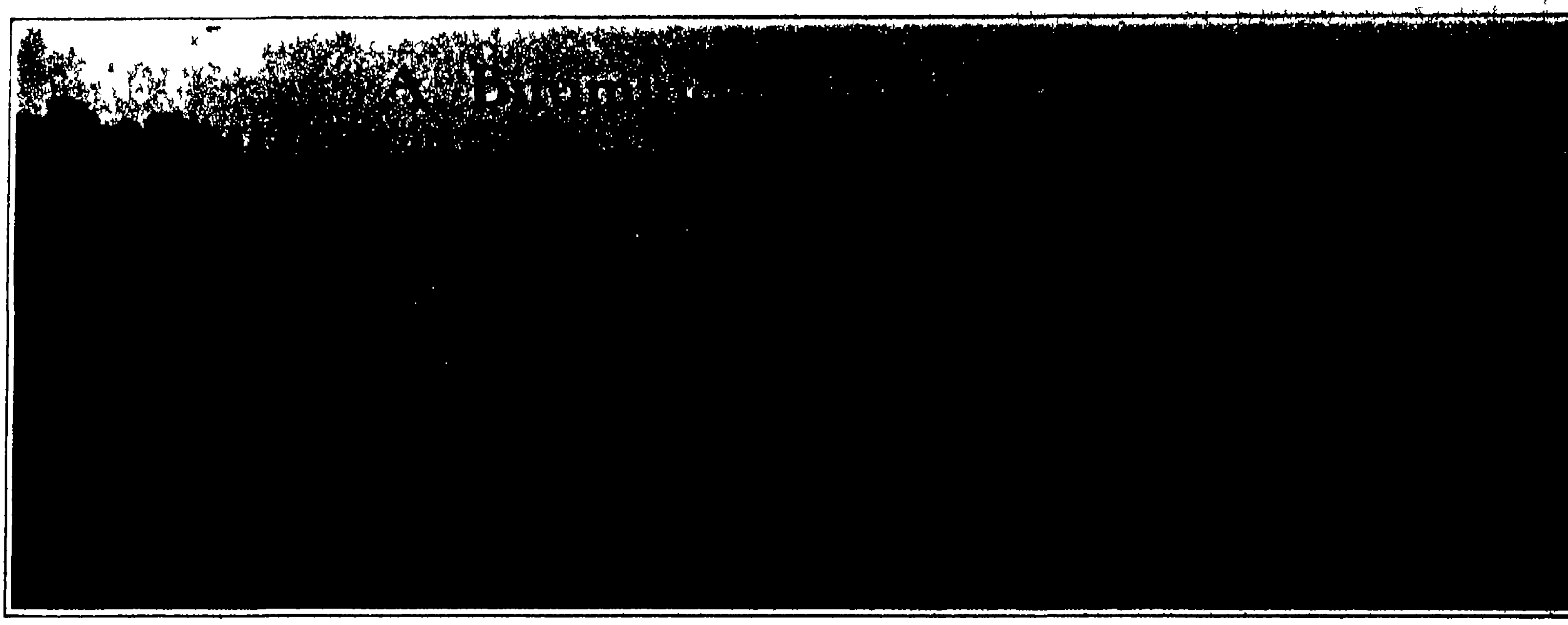
The Hoof of the Horse

There are toes on a horse's hoof just as there are on the foot of a human being or on the foot of any animal that resembles the human foot. Furthermore, a horse has toe nails. The horn of the hoof grows in pretty much the same way that a toe nail does.

The growth of the hoof is more rapid in unshod horses than in the case of those wearing shoes. It grows still more rapidly in the case of horses that are well groomed and well fed. Generally speaking, however, the horn grows about one third of an inch each month.

Hind hoofs grow faster than fore hoofs. The toe of the hoof being the longest part, it takes longer for the horn to grow there than at the heel. For example, the toe will grow entirely down in from eleven to thirteen months, while the heel will grow down in from three to five months.

As the new horn grows out, any cracks or defects in the old gradually work down to where they may be cut off, just as in the case of the growth of human nails one can watch the progress of a bruise from the root to the tip.



THE WASTE TAKEN OFF THE LEDGE SHOWS THAT PART OF QUARRY IS ABOUT WORKED OUT

TEN miles northwest of Santa Cruz California there is an interesting deposit of bituminous rock Here fifty five men work the year round to get out 40 000 tons of the best road making material known Of all the mines and quarries I have seen this seems to be the most pleasant one in which to labor High up on the side of a hill three miles away and a thousand feet above the level of the sea with a fine breeze most of the time and where it is never too cold and with but a few days in summer when it is warm—is situated this clean safe and profitable mine

After taking off 125 feet of waste shale there is exposed a 40 foot stratum of bituminous rock except for a 10 foot layer of waste near the middle

By running this rock through a steam cooker or heater and without the addition of any binder such as tar or asphaltum it is spread upon the rock foundation and makes a clean and lasting surface for a street

Asphalt m is the binder or mineral that makes this out rock of sand valuable It is found in many parts of the world sometimes in a pure state but more often mixed with fine sand earthy matter or pebbles It melts at about 212 deg F and in this form is known as bituminous rock California is the only State in the Union in which it is worked commercially

Macadam foundation covered with two inches of bituminous rock will cost about 23 cents per square foot concrete foundation with two inches of bituminous rock will cost about 32 cents per square foot Side walk will cost about 10 cents per square foot In all this paving work one of the most important things to do is to make a good foundation without this no matter how thorough the cooking and the laying of the cover may be the work will go to pieces

The fresh broken rock is very tough and waxy and in color it is not black but a fine steel gray Black powder is used to blow off a great mass before it is broken up into small pieces with giant powder and with wedges picks and bars It weighs 80 pounds per cubic foot and 10 tons make a load for a six horse wagon to draw down to the railroad

One of the stories told about this mine is that it was first worked in the 60 s for the distillation of kerosene and another is that later they tried to use it for paving material but always got it too hard or too soft.

The man is still living near here to whom it was offered for little or nothing if he would take it off the owners hands and make some use of it He is poor and working for his living while there is in sight 3 000 000 tons of rock worth $3 per ton F O B

Some fossils and bones and teeth of animals are found in the 10 foot stratum near the middle of the outcrop

This bituminous rock has probably been formed by a layer of sand becoming charged or saturated with crude oil the lighter parts of which dry out or are vaporized leaving the heavy asphaltum bare to bind the grains of sand together

Charles Darwin—III*

By AUGUST WEISMANN

Concluded from SUPPLEMENT No 1844 page 275

THE principle of selection shows us how the thousands of adaptations in living beings which arouse our constant admiration may have arisen in a purely mechanical way And they must necessarily have done so if the evolution of the living has resulted from the same forces and laws as the not living in other words if in explaining natural phenomena, we can leave out of account altogether any forces outside of or beyond nature The principle of selection enables us to do this and therein lies its far reaching significance It is I believe the discovery of this principle that will make the name of Darwin immortal Wallace too deserves a full share of the credit, although he did not base his theory on such a broad foundation of facts, and did not apply it in so many directions

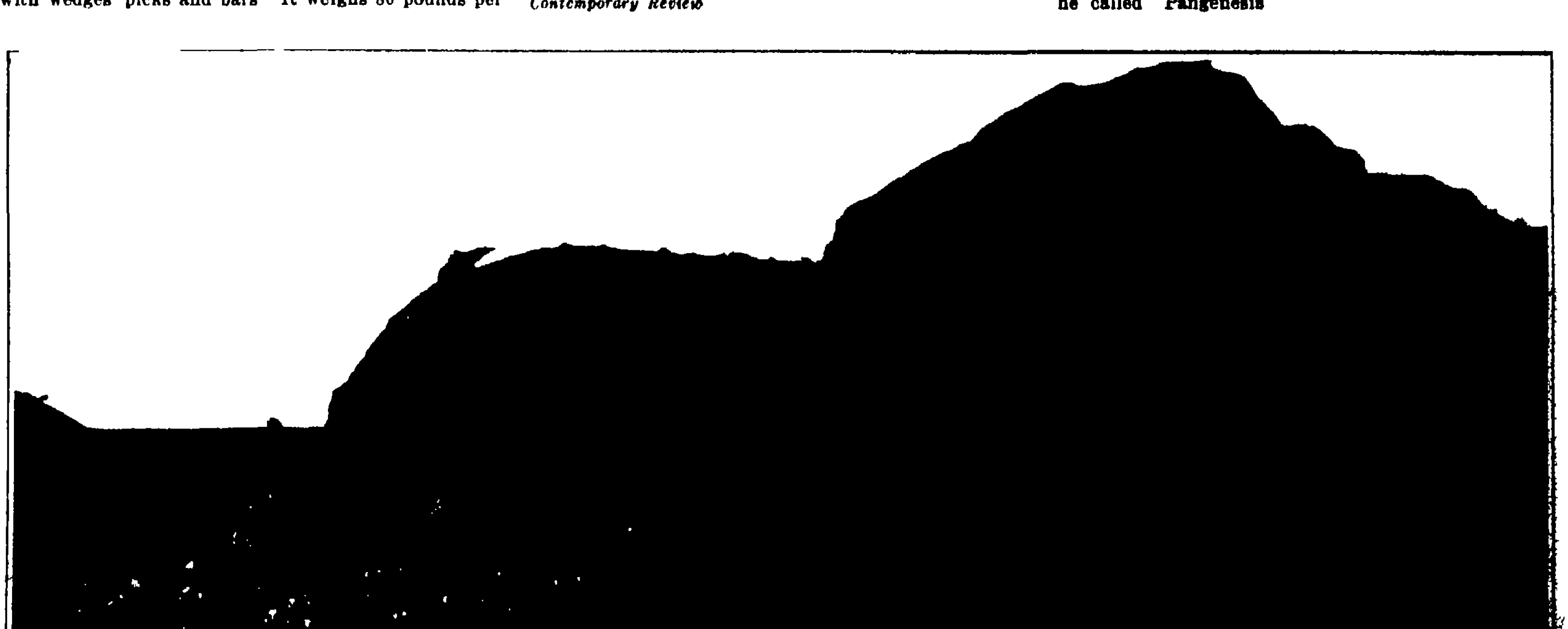
This principle is fully developed in "The Origin of Species by Means of Natural Selection as indeed the title of the book shows It might be thought that the publication of this book finished the labors of the hermit of Down but this was not the case It was followed by the richest creative period of his life Between 1860 and his death in 1882 he issued a whole series of works small and large each of them based upon numerous observations and experiments and most of them containing wholly fresh associations of ideas usually connected directly or indirectly with the theory of evolution and sometimes extending and corroborating it more fully I must at least give a few indications as to the nature of these books

In 1862 Darwin published his book The Various Contrivances by Which Orchids are Fertilized by Insects Orchids often exhibit the most special and diverse adaptations to the visits of insects and they help to make clear to us how flowers may have been developed in all their manifoldness in relation to the needs of their insect visitors

In the same year and those following there appeared several treatises on Dimorphism in the Flowers of Primula Darwin had discovered minute differences in the length of the stamens in the same species and he demonstrated that these differences are not mere chance variations but are adaptations which secure the crossing of individuals and prevent self fertilization He obtained the proof of this through many careful experiments

This was followed in 1864 by a treatise on The Movements and Habits of Climbing Plants showing the different ways in which they climb—another study in plant adaptations In 1868 appeared the great work begun in 1860 The Variation of Plants and Animals under Domestication and this book greatly extended and strengthened the basis of his theory of selection The phenomena and laws of variation and heredity are discussed and illustrated by a wealth of examples and the work concludes with a theory of heredity which he called Pangenesis

* An address delivered at the University of Freiburg on the occasion of the Centenary of Darwin Reprinted from *The Contemporary Review*



QUARRY SHOWING THE BARREN SHALE ABOVE THE 40-FOOT STRATUM OF BITUMINOUS ROCK

A BITUMINOUS ROCK QUARRY

"The Descent of Man" appeared in 1870 Up till that time Darwin had made no definite pronouncement upon this subject, though of course he must from the very first have deduced from the variability of species that man also was a product of evolution He now discussed this view in detail in a two-volumed work which also contained a fuller treatment of an aspect of the theory of selection only briefly sketched in "The Origin of Species. Here the phenomena of sexual selection" are traced throughout all the animal groups in which preferential mating plays a part The principle is illustrated by a positively overwhelming mass of detailed facts and is shown to have been a factor even in the differentiation of the sexes in the human race

Closely associated with this work is the one which followed it in 1872 on "The Expression of the Emotions in Man and in Animals The birth of Darwin s first child in 1839 had induced him to record in a special note book all his observations on the gradual awakening of the sensations and their expression on the features of the child for he was convinced that even the most complex and delicate emotional expressions of man had their natural roots in animals just in the same way as the part of the body and the mental faculties For thirty two years he followed out this idea experimenting observing collecting facts until finally he was able to write his remarkable and fascinating book, the first English edition of which consisted of 5 000 copies

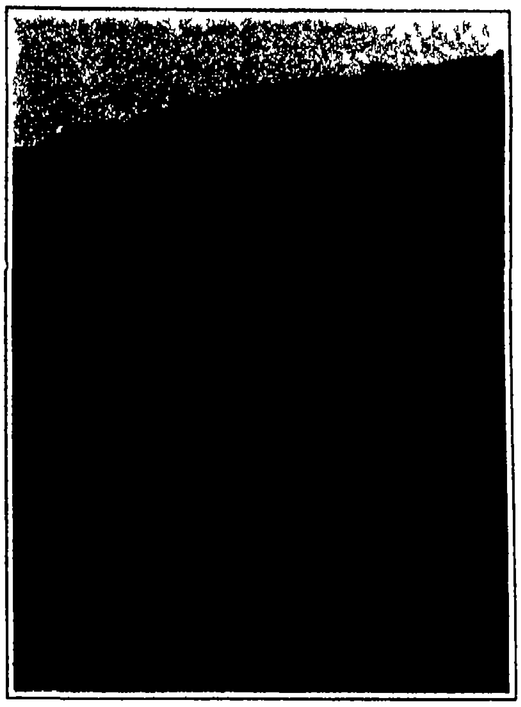
Darwin s next book appeared in 1875 and this also had been a long time in course of preparation In ranging about the country during a summer holiday in 1860 he had noticed a dainty little plant, the sun dew (*Drosera rotundifolia*) to the viscous leaves of which several small insects were usually found adhering Many other collectors had noticed this because of the difficulty of procuring a clean specimen for the herbarium Darwin took a few of the plants home with him and soon discovered that certain parts of the leaves exhibit movement as soon as small insects are brought into contact with them This led him to the discovery of Insectivorous Plants and his book bearing that title was published fifteen years later

In 1876 Darwin published a work on Different Forms of Flowers on Plants of the Same Species, and in 1880 jointly with his son Francis The Movements of Plants" Finally in 1881 the year before his death there appeared The Formation of Vegetable Mould through the Action of Worms This last book like some of the earlier short treatises had no direct connection with the theory of evolution but it illustrates in a very characteristic manner Darwin s eminently scientific mood which led him to note everything that seemed unusual or interesting in the most ordinary things and to follow it out till it led him on to new discoveries How many hundreds of people and even of naturalists had seen the little earth-castings that cover the damper parts of our garden paths on summer mornings These are due to earthworms and are the remains of the decaying leaves on which they feed The earthworms cover the whole land with fertile mold and through their agency in the course of time the surface of the ground is raised and bad soil is transformed into good [1]

But no one had deemed the phenomenon worthy of attention It is a case parallel with that of the sun dew which hundreds of botanists had passed by without ever suspecting that the adherence of the insects was more than a matter of chance.

The fruitful discovery of the struggle for existence" too was due to this vision of the true naturalist, who sees in what lies before him much that others pass by unheeding It was certainly no chance that the struggle for existence first revealed itself to men who had spent the greater part of their lives in the open air no chance that it was two travelers like Darwin and Wallace who first perceived the dependence of one species upon another and the competition between them

From the little that I have been able to tell you of Darwin s life in Down you can gather what a rich



MASS OF ROCK BLASTED OFF THE LEDGE AND BEING BROKEN UP

full life it was You will now wish to hear something of the man himself and his character Unfortunately I never saw him An affection of the eyes which has troubled me for forty five years and has restricted my activities in many directions prevented my traveling to England while Darwin still lived and was relatively vigorous Therefore I can not sketch the impression made by his personality from experience But we have a short autobiography which reveals his nature clearly and in addition a most detailed and sympathetic picture of him by his son Francis.

He was tall nearly six feet in height and his most striking features the high forehead the large prominent and bushy eyebrows the blunt nose and energetic mouth are well known No one interested in Darwin s personality should fail to read both Francis Darwin s account of him and his autobiography Taken together they give a picture of the man which could not be more truthful and could hardly be more complete

Add to this picture what we can gather from his scientific works and especially from the accounts of his journey and we find that he had a great and comprehensive mind concerned in the main with general conceptions yet possessing in a high degree the faculty of becoming sympathetically absorbed in detail He took pleasure in small things as in large and was able alike to study with the most painstaking minuteness the structural details of a flower or a crustacean or to draw far reaching conclusions from an enormous number of isolated facts He possessed the fundamental qualities of a naturalist great powers of observation and absolute accuracy the most extreme caution in judgment is revealed in all his writings and his presentment of his ideas is always simple and entirely free from arrogance or vanity for a great natural modesty was one of the main features of his character But his theories clearly show that he was not lacking in imagination for they could never have been thought out without it He was not a keen critic grasping a thing quickly and illuminating it at once he was on the contrary rather inclined to take too favorable a view of the work of others and had a tendency by no means very common to acknowledge the achievements of strangers and to take a positive delight in them His mind was of the penetrating order which work persistently at any problem until he began to see light on it

He was not concerned with practical aims he was an idealist who desired knowledge for its own sake, and not for any utilitarian end a naturalist who worked for pleasure in the work itself and rejoiced in the advancement of science his work brought about

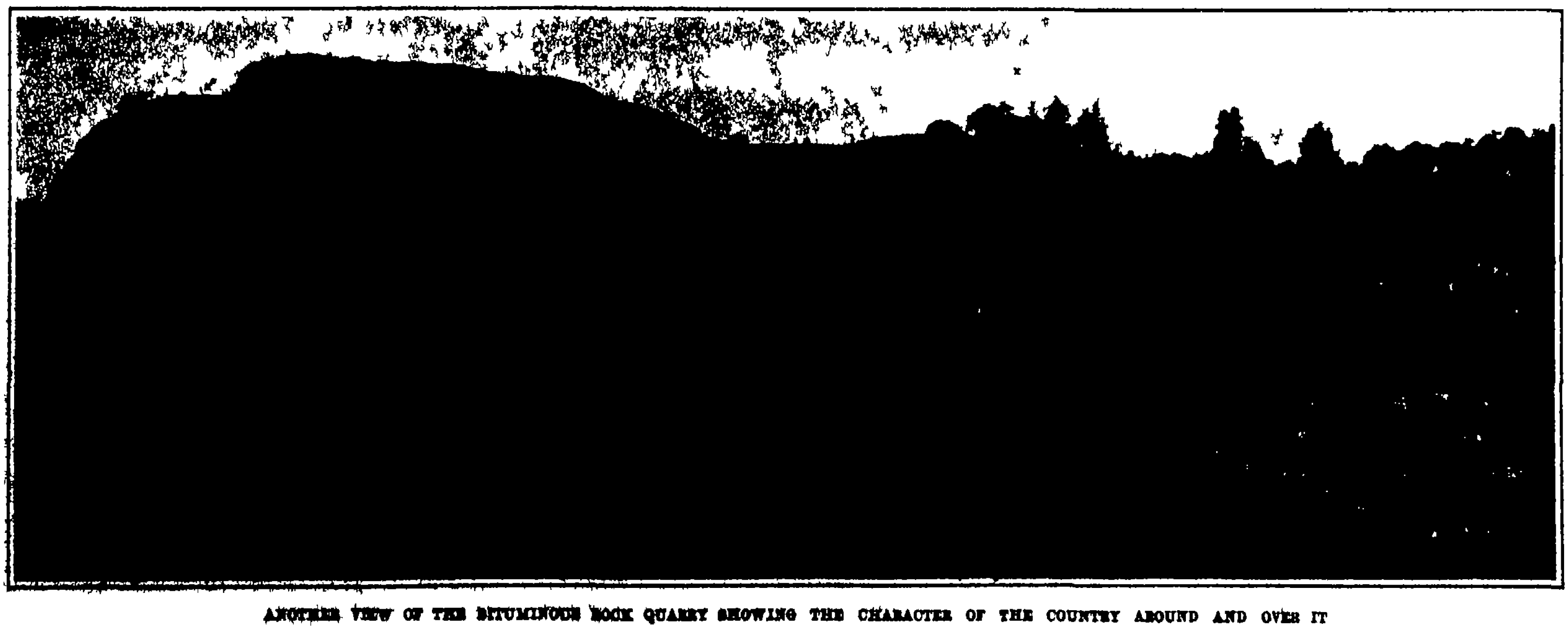
He was not lacking in ambition but it was ambition on a large scale not to gain fame and position but to create works which should seem to him worthy Fame came unsought and as he tells us it was a satisfaction to him to feel that he was held in esteem by those whom he himself esteemed

He has sometimes been called an amateur and in a certain sense this is true in as far as he worked in several different scientific provinces each of which requires a man s whole strength But he had full command over these different provinces at least as far as was necessary for the end he had in view He was certainly not a restricted specialist The zoologists accepted him as a zoologist the botanists as a botanist, perhaps also the geologists as a geologist But he was not an expert in any or rather it would be more correct to say he was so wherever he himself had done productive work For he was essentially self taught and had passed through no normal school of zoology or botany but with his great energy and unflagging industry he had acquired a profound knowledge from books and from personal intercourse with specialists and every piece of work he did added to this store of knowledge He was perhaps the last not merely to survey but to do productive work in every domain of biological science Yet I will not assert this for we have all been convinced in recent times through the evolution theory that it is not enough to be at home in a single science it is necessary also to have at least a general acquaintance with the essentials of allied branches

Darwin has sometimes been accused of being one sided of caring for nothing but his science But this was not the case it is less true of him than of many specialists in natural science He had a wide knowl

[1] In regard to the earthworm I must note that my countryman, Professor Hensen the excellent zoologist of Kiel displayed the same acuteness of observation and drew the same conclusions from the castings at the same time as Darwin did

Life and Letters of Charles Darwin including an Autobiographical Chapter Edited by his son Francis Darwin London 1887



ANOTHER VIEW OF THE BITUMINOUS ROCK QUARRY SHOWING THE CHARACTER OF THE COUNTRY AROUND AND OVER IT

A BITUMINOUS ROCK QUARRY

edge of English literature Milton and Shakespeare having been his favorite readings in his youth In later life he had novels historical works and books of travel read aloud to him every day He was fond of music too though as we have said, he had no musical ear

Darwin was a man not only of lofty noble spirit but of the tenderest feeling Let anyone who doubts this read the touching pages in memory of his little daughter Annie who died young they form one of the most beautiful memorials ever dedicated by a father to his child His son s picture of him too reveals the beautiful and intimate relations that prevailed between them and the whole quiet and joyous life of the Darwin family testifies to the cheerful and affectionate disposition of its head

It remains to estimate the influence of Darwin s theories on his time and on the future But this is a task for which a whole book would not be too much and a task moreover which could be better accomplished on the two hundredth than on the one hundredth anniversary of his birth

We can at least say however that the influence was a great and many-sided one and that it will endure throughout all time All who know the position of science before 1859 will be ready to admit this the younger generation have grown up so thoroughly under the influence of Darwin s ideas that it must be difficult for them to realize the state of matters before his day

Let us speak of biology first But was there a biology then? Strictly speaking there was not there was zoology botany and even anthropology Each of these sciences consisted of a very large and well arranged mass of facts but with no intrinsic coherence among them This was supplied by the theory of evolution The different departments of science were not even then regarded as complete It was well known that there were many gaps in our knowledge but we were only seeking for missing details whereas in reality it was the main thing that was lacking—the unifying idea which Goethe had sought for and tried to supply in his theories of the plant prototype and of the skull

The science of embryology or as we now call it ontogenesis at that time consisted of a great number of observations interesting enough but without any recognized unity It was not a harmonious structure but a collection of finely-cut building stones But what a change when the luminous idea of evolution was added! Life seemed to be infused into the stones and almost spontaneously they formed a magic edifice The ovum now at last recognized as a cell was seen to be a reminiscence of the descent of all higher animals from unicellular organisms rudimentary organs such as the rudimentary eyes of blind cave animals were found to be sign posts indicating the racial history of those animals and pointing back to their sight-endowed ancestors This evolutionary view illuminated the whole science and not embryology alone but also comparative anatomy the understanding of the structure of animals. It became plain why the New Zealand kiwi should have little rudimentary wings under its skin, although it does not fly It is not in order that it may conform to an ideal of a bird, as was previously thought, but because its ancestors had possessed wings which were used in flight.

Physiology also gained much especially the theory of reproduction of heredity of organs of the cell and especially of the cell nucleus I do not mean to say that all these were the direct result of the idea of evolution but they have an indirect connection with it

Anthropology gained quite a new interest after it was recognized that man too was a product of evolution A vast number of problems presented themselves It was necessary to investigate the gradual becoming not only of the body but of the mind, the evolution of the Psyche and all that flows from it. Before that time there had been a history of language of law of religion of art and so on but it now became necessary to carry these further back—beyond Adam and Eve to the animal ancestors Undoubtedly a study of the phychology of animals is one of the essential tasks of the future! I can here only give a few hints without elaborating them but I must emphasize the fact that the idea of evolution in the form in which Darwin presented it to us has given an impulse to new life and further development in every department of human knowledge and thought everywhere it acts as the yeast in cider—it sets up fermentation This has already borne rich fruit, and we may hope for much more in the future

Our greatest gain from the theory of evolution has however been the evidence it affords of the unity of nature the knowledge that the organic world must be referred back to the same great everlasting laws which govern the inorganic world and determine its course Even if formal proof of this be still wanting the probability is now so strong that we can no longer doubt it.

It is not only the theory of evolution as a whole but the active principle in it the principle of selection that is transforming and illuminating all our old conceptions It is teaching us to understand the struggle silent or clamant among human races their rivalry for the possession of the earth and to understand too the composition of human society the unconscious division of labor among the members and the formation of associations. The development of classes and their union in a State appears in a new light when looked at from this point of view In this department a good deal has been already accomplished

The study of human health must be particularly influenced by the theory of evolution and a beginning has already been made in this department also

But there is another and very important point in regard to which the theory of selection must be our guide If we take a survey of the evolution of the world of life as we know it we see that, on the whole it has been an ascending evolution, beginning with the lowest organisms and advancing through higher and higher to the highest of all, man himself. It must be admitted that at certain stages in this evolutionary series we find retrograde steps (as, for instance, parasites and sedentary animals), but on the whole the direction of evolution has been an ascending one

I see no ground for assuming that this will be otherwise in the future According to the principle of selection the best will survive in the future as in the past, and mankind will ascend I do not believe we are likely to undergo any essential changes in a crude physical sense, we are not likely to grow wings, and even our mental powers may not be capable of much further improvement, but ethical improvement seems to me not only possible, but probable on the principle of selection Mankind will never consist of wholly selfless saints but the number of those who act in accordance with the ideals of a purer, higher humanity in whom the care for others and for the whole will limit care for self will it is my belief, increase with time and lead to higher religions, higher ethical conceptions as it has already done within the period of human existence known to us. But here again I can only indicate without following out my ideas I wished to express them because the principle of selection has so often been applied in an inverted sense as if the brutal and animal must ultimately gain the ascendency in man The contrary seems to me to be true for it is the mind not the body that is decisive in the selection of the human race

Thus we see the principle of evolution intervening transforming re-creating in every department of human life and thought and endeavor We owe this principle which has been so fruitful in results mainly to Charles Darwin, though he was not the only one nor the first to think it out But it was he with Wallace who secured it its place in science and made it a common possession of mankind by working it out in all directions and supporting it with another principle that of selection which explains the riddle of the automatic origin of what is suited to its purpose in nature Thus he cleared away the obstacle which would otherwise have stood in the way of the acceptance of the theory of evolution

By all this he has earned enduring fame in the annals of science His own country has not been ungrateful to him A colossal statue of him in marble decorates the British Museum from the background of the entrance hall he looks down on the passers by with the calmness of the sage His mortal remains lie in Westminster Abbey beside those of Newton

Fate too was kind to him He could truly say that his life was a happy one for it was filled with a great idea and he was supported by the consciousness that Goethe expresses through his Faust Es kann die Spur von meinen Erdentagen nicht in Aeonen untergehen This is true of Darwin and we may think of him as one of the great immortals among men

The Modern Motor Car*

Ten Years' Progress

By W W Beaumont

Motor vehicle engineering as generally understood may be said to be all modern although in fact it was born in England about 85 years ago Taking however only the ten years of the present century a survey of the advances which have been made will show that as a branch of engineering its progress has been unprecedented that the industry it has established has reached the incredible and that the new knowledge it has acquired to the advantage of metallurgy and other arts and manufactures has placed it in the front rank as a philanthropist to science

Early in 1900 the inventions and patient investigations of Daimler Butler Maybach Benz and a few original contributors in a less degree fostered by the mechanical skill of Levassor Peugeot, Mors, Renault, and others had proved so full of practical and commercial value that a large number of motor vehicle manufacturers had become established in Germany and France together with a few in England including the Daimler Company the Lanchester the Wolseley the New Orleans Star and Napier Vehicles from all these makers and more were among the 65 which started from Hyde Park Corner in April, 1900, on the 1 000-mile endurance and hill-climbing trial of the Automobile Club and of them 49 with more or less complete records entered the Crystal Palace and were exhibited there in the following month With two exceptions the whole of the vehicles exhibited were fitted with engines of the types originated by the first named inventors and makers the exceptions being small steam cars one of a type now not seen in this country Most of those which had not the type of gear transmission of the Daimler Levassor origin and Daimler Panhard Levassor, and Mors construction were of the very small powers now out of date

THE ENGINE.

To start from this preliminary as to what the courts call the state of the art of ten years ago a few comparisons may be made with present conditions In the first place the power of the internal combustion engines used to-day is on an average at least three times that of 1900 In that year the 12 horse-power Panhard engine represented the most advanced form of construction A Mercedes (Cannstatt Daimler) car of nominally 24 horse-power ran in the Nice-Marseilles race of March that year but its average speed was from five to ten miles less than that of five Panhard cars in the same race. All these engines had hit-and-miss governing and valve-operating gear with exposed cam shaft gearing, but they for the first time used the magneto-ignition apparatus which had been for years used by the French gas engine makers. Up to that time the engines of this type had been fitted with the flame-heated ignition tubes, with consequent inferiority as to period of ignition and pressure effects. Mors had, however, used one complicated type of electrical ignition, and Benz had always used another and simpler form but confidence in electric ignition was not established until after the Bosch magneto had been in use some time To-day electric ignition is universally fitted and the cars run many thousands of miles with it without any uncertainty engines of the same diameter of cylinders giving very much higher actual power than they did formerly At noise trials in 1900 it was a question of which engine made least noise, now it is more nearly a question of which engine makes any, even though quadruple the power is developed.

These advances have been obtained by the employment of valves of dimensions, forms seating, and ports of now known proper forms together with inclosed valve-operating gear beautifully made, by precise construction of valve-operating mechanism and cam forms, by the use of modern tools and methods which insure accuracy equal or superior to standard gages of a generation ago, and by the utilization of high property metals which permit a lightness in the construction of parts not dreamed of but a few years ago Steels of from 40 to 100 tons tensile strength and considerable toughness have been made at the suggestion of the automobile builder and largely as a result of the strenuous competition for pre-eminence in the race and other trials organized by the French and by the Royal Automobile Club

Things and materials which were the best possible in 1900 might to-day be looked upon as makeshifts,

* Engineering Supplement of the London Times

and very possibly the same remark will be true in 1920; but it is safe to say that there is no more perfect piece of machinery in the world to-day than the engine and other mechanism of the well made motor vehicle, and there never has been such perfection in the material, workmanship and performance of the finished thing.

TRANSMISSION AND GEARS

In 1900 the transmission mechanism was only beginning to be so completely inclosed as to run immersed in the most suitable lubricant and the transmission was in nearly all cases by chains exposed to every cause of wear. To-day by the use of the excellent steels that have been brought into existence for the purpose the gear wheels are of half or less the weight possible in 1900 and they run in oil tight gear boxes so that the teeth have hardly time to squeeze the oil from between their contact surfaces before they have passed each other with the result that their wear is almost insensible after propelling a car thousands of miles at average speeds which in 1900 were racing speeds.

The change speed gear of nearly all the cars of to-day including the best is of the longitudinally sliding type, as it was in Levassor's cars of 1895. This was then to the mechanical engineer a makeshift, but he had not then made the experiments he has since made with every other type of gear he has been able to devise. He therefore did not know that ten years would only show him that what he thought a makeshift was a good devise because by careful attention to the relations between the different speeds of the gear by study of the number pitch, and form of the teeth by the removal of unnecessary inertia stresses by lightening parts the acceleration of which had to be suddenly varied and by the improvement of the transmission to the gear this type of gear change could be made the best possible when all practical requirements are considered with reference to both the hypothetically and the expediently best.

Transmission to the driving axle by exposed chain is now but little used and direct driving by either worm and wheel as first used in motor cars by Lanchester or by bevel pinion and wheel all parts being inclosed is to-day most in use. The whole of the parts are made of very high grade materials and in good cars, are fitted with a precision impossible in earlier years. The improvements in the change speed gear and final transmission gear make it possible in cars having the now usual flexible engine and good clutch to change from one speed ratio to another in such a way that there is neither jerk nor noise and the passenger in a car does not know a change has been made. Improvement in this respect however is much wanted in motor omnibuses though with the changes that are being made and are yet to be made it will be forthcoming.

In 1900 speeds were much lower than are common to-day and comparison of the gasoline consumption then and now is not likely to be very trustworthy because it is difficult to allow for road and air resistance at the speeds at which consumption trials were made in 1910. Without such allowances the comparison is in favor of the best 1900 car—which is obviously wrong especially when the smaller weight of car per horse-power to-day is taken into account. It is not however at all certain that the carbureter of to-day is better suited to the average engine of to-day than was the simple Maybach carbureter to its engine of 1900, and there is no reason why it should be. Misconception prevails even yet as to carbureters as is shown by the fact that the best surface evaporator carbureter even now does not give the engine a carbureted air by which it can use gasoline more economically than with the ordinarily good jet or multiple jet carbureter. The makers of motor vehicles on a large scale have devoted the most painstaking and unrestricted experimental attention to this detail of the motor car well knowing the differences between the thing that will perform best under the varying conditions and circumstances of a carbureter on a car and the perfect carbureter in a laboratory.

BODYWORK

The car of 1900 had driving wheels larger—and sometimes much larger—than the front wheels and the general dimensions were influenced by those of ordinary vehicles. *Conflicting requirements thus made* the motor carriage body uncomfortable as a consequence of height of floor and deficiency of leg room. Much was said about inartistic design of bodies—but no artist offered any solution complain as much as he would of what was made. Ultimately the motor vehicle has become the most comfortable and luxurious of all known vehicles at the same speed on the same road as a result of the efforts of the motor car builder. He has had to produce bodies which are not only accepted as having every evidence of fitness but which will also withstand the shocks strains and vibrations of high speed over bad roads and show less of depreciation than would any other body work with a tenth of the mileage and one third of the average speed. It is known that when cab and hansom owners had to adopt rubber tires they saved a large part of the whole cost by the difference between the cost of the body upkeep with and without such tires. What the cost of the old cab and hansom upkeep would have been at an average speed of say 25 miles an hour with a travel of 400 miles a week can be estimated by those who are informed on these matters and they will be able to affirm that the improvement during the last ten years in body building and finish as applied to motor vehicles is the difference between an admittedly temporary makeshift and a satisfactory stage toward perfection.

A very great part of the whole of the depreciation of a motor vehicle is caused by the severity of the jolting twisting and vibration resulting from modern speed on roads most of which are not modern. Much may be done by elaborate springing by shock absorbers which refer the shock to the wheels and axle and by other means but ingenuity of this kind is expended in fighting what must be hoped to be a declining enemy. It is not a sensible proceeding that insists on multifarious appliances which may enable a car to run at high speeds on badly paved roads when it is known that generally the car will in fact run on much better roads and that a slow speed on the bad ones will avoid most of the trouble and discomfort and thus make these appliances unnecessary. To a very great extent the motor problem is a road problem and although all horse pulled vehicle owners have always taken bad roads as they do thunderstorms there is no reason why engineers and motor car owners should do so especially as good roads well and continuously maintained are in the end cheap.

DURABILITY

The comfort of motor vehicle travel has increased in the last ten years to an extent that can only be known by those who traveled much by car in all seasons in 1900. Involuntary stoppages on the road except for tire punctures or the like are many hundreds of miles apart, and stoppages owing to mechanical defect in a good and well kept car are now causes of surprise. The 15 000-mile trial of the Rolls-Royce car by the Royal Automobile Club shows what is possible in this respect the wear at the end of that distance not being measurable in any but an unimportant detail and the whole cost of repair only a few shillings. On other cars the writer has run 7 000 miles without a single mechanical stop and over 4 000 miles without a single tire stop of any kind. This is mentioned because it has been suggested that things are not what they seem in motor vehicles and because it is said that durability and other trials are wanted. But durability trials are being carried on now by about 6 000 cabs and about 1 000 motor omnibuses in London alone and by many thousands of owners of other vehicles of various kinds. A great deal of this practical trial running may be said to be through the owners within the cognizance of the makers of the vehicles they and the omnibus and cab companies and their engineers are getting the experience the real knowledge of the weaknesses the defects and the good qualities and points. A motor omnibus runs from 25 000 to 30 000 miles a year and during that time its engine and gear will make many millions of revolutions and have to be equal to the arduous work of starting hauling and stopping a vehicle and load of over six tons every few minutes.

SIDE SLIP AND BRAKES

During the ten years many devices for preventing side slipping have been invented but they have not been free from the defects that (1) they involve inconvenient additions of appliances (2) they need prevision on the part of the driver alertness not being sufficient (3) they destroy the road surface or (4) they are ineffective. Good driving and cleanly roads are the true side slip preventers.

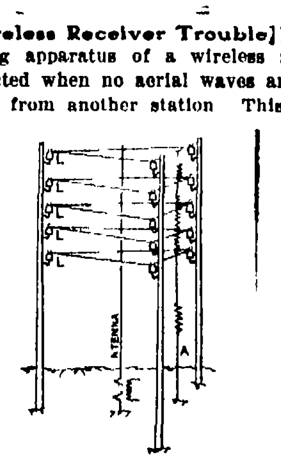
Brakes are now so generally well designed and well made that on the good cars of to-day if kept in adjustment they are quite trustworthy. A brake which is more than sufficient to skid the wheels is easily obtained but it is not a very desirable thing to put into the hands of most drivers and additional stopping appliances would probably be more expensive or troublesome than the wear of tires so long as tires are not skidded. A perfect brake such as an electro-magnetic brake without surface contact but depending only on cutting lines of force is hypothetically pretty but the ordinary brake which wears and causes some wear of the tires is in practice a better expedient—just as a leather boot sole which wears out is better than a copper sole which would last a lifetime. In conclusion then it may be said that the improvements made in the motor car during these ten years have been such as to earn universal appreciation even if not to remove all opportunity for the adverse and non constructive critic.

Poisoning by Gas from Heaters

A FACT which has a great practical bearing was brought out not long since by two French scientists relating to the slow poisoning of the system by gases given off from certain kinds of heaters used in private houses or hotels. Heating by hot air is not free from danger, according to their information and it appears that thirty-five persons who lived in a large hotel where hot air heating was used were subjected to a slow poisoning by gases and this gave some bad effects. It is carbon monoxide gas which causes the poisoning in this case and only a small quantity is needed such as 1 in 1 000 or in 10 000. In the present case some of the persons who lived in rooms which were free from this gas, did not show any bad symptoms. As to the others they showed troubles of different kinds nervous digestive or general. Among the nervous troubles were noticed vertigo fatigue insomnia or neuralgia. As to general symptoms we note that the persons lost flesh and became pale. These effects come from living for some time in the contaminated air but when the persons went to another place the symtoms disappeared or at least were lessened. Examination of the furnaces showed that they were very defective in their construction. It appears that some cities have the habit of mixing water gas with city gas, and for heating purposes this is a positive source of danger, and mortality from such causes is increased. We should remember that bad effects from the presence of gases are not easily detected at once, as the action is very slow, and thus the system may in time be very much affected when it is too late to take the needed precautions. Drs. Courmont and Mouriquand brought out these facts before the Paris Academy of Medicine.

Wireless Receiver Trouble

THE receiving apparatus of a wireless station is sometimes affected when no aerial waves are coming to the antenna from another station. This phenomenon is known as receiver trouble. It sometimes becomes very annoying and in the tropics often makes regular communication impossible during a period of twenty four hours. Investigations made at the Graefelfing station indicat that the trouble is due to atmospheric electrical disturbances caused by radioactivity.



ANTENNA SURROUNDED BY FARADAY'S CAGE

The earth is usually negative with respect to the air and the negative charge of the antenna favors the accumulation of radioactive deposits, which strongly ionize the air in the vicinity. Hence each wire of the antenna surrounded by a cylinder of air of abnormally high conductivity. The protrusion of the earth connected antenna into the atmosphere also distorts the equipotential surfaces and produces an abnormally high potential gradient over the antenna. The combination of high potential gradient and high atmospheric conductivity produces an abnormally great flow of electricity from the air to the earth through the antenna, and the variations of this flow set up electrical oscillations which affect the receiving apparatus.

These disturbances can be prevented by inclosing the antenna in a Faraday's cage with all of its wires placed horizontally so that they have no component in the direction of the electrical vector of the waves coming from other stations and consequently do not interfere with the reception of messages. These horizontal wires denoted by *LL* in the diagram are provided with an aperiodic or non oscillatory earth-connection *A*.

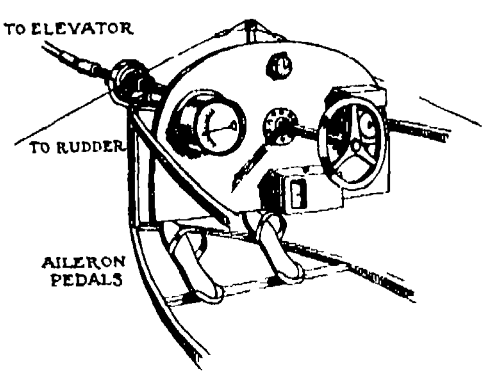
BEFORE a French scientific society M. Jouve has described the remarkable resistive property of ferro-silicon and other alloys of silicon. Nitric acid even as a vapor does not affect these alloys at all. Sulphuric and hydrochloric acid also have no effect. The same is true of acetic acid. The high price of platinum gives importance to ferro-silicon as a substitute to be used in the manufacture of acid resisting vessels but the alloy possesses a disadvantage in its brittleness and the thickness and weight of the vessels made of it.

The Maurice Farman Biplane

Scale Drawings of the Machine that Flew from Paris to the Puy de Dome

The Maurice Farman machine as first built, toward the end of 1909 was distinguished by the fact that it had vertical panels at the rounded extremities of the main planes and ailerons on the lower plane only The chassis was composed of skids and castor wheels Two smaller wheels supported the tail In 1910 after an alliance had been made between Henry and Maurice Farman the side panels were discarded and four ailerons were used The two small wheels supporting the tail were replaced by a skid From this period also dates the adoption of a rear elevator acting in conjunction with the front elevator Later in the military model the upper plane was extended In the Puy de Dôme model the castor wheels have been exchanged for those of the Henry Farman type and the leading edge of the main planes is now in line with the front uprights instead of being a foot in advance of them

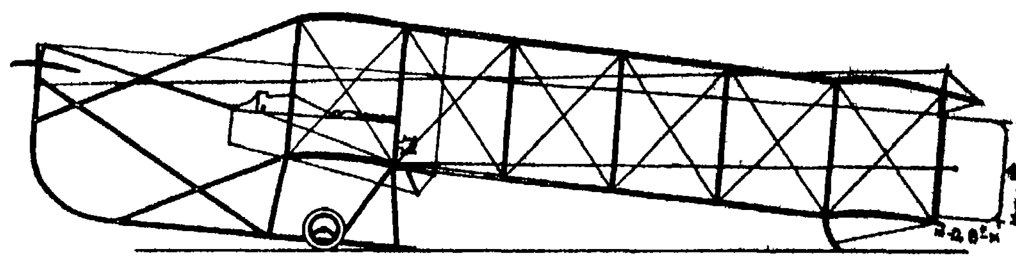
The surface of the main planes which are covered with Continental fabric is 635 square feet, and the aspect ratio is 8 to 1 The weight of the machine is about 1 210 pounds and the speed 48 miles per hour A 60 horse power Renault air cooled 8-cylinder, V type motor has always been employed The Chauvière propeller is driven off the half time cam shaft



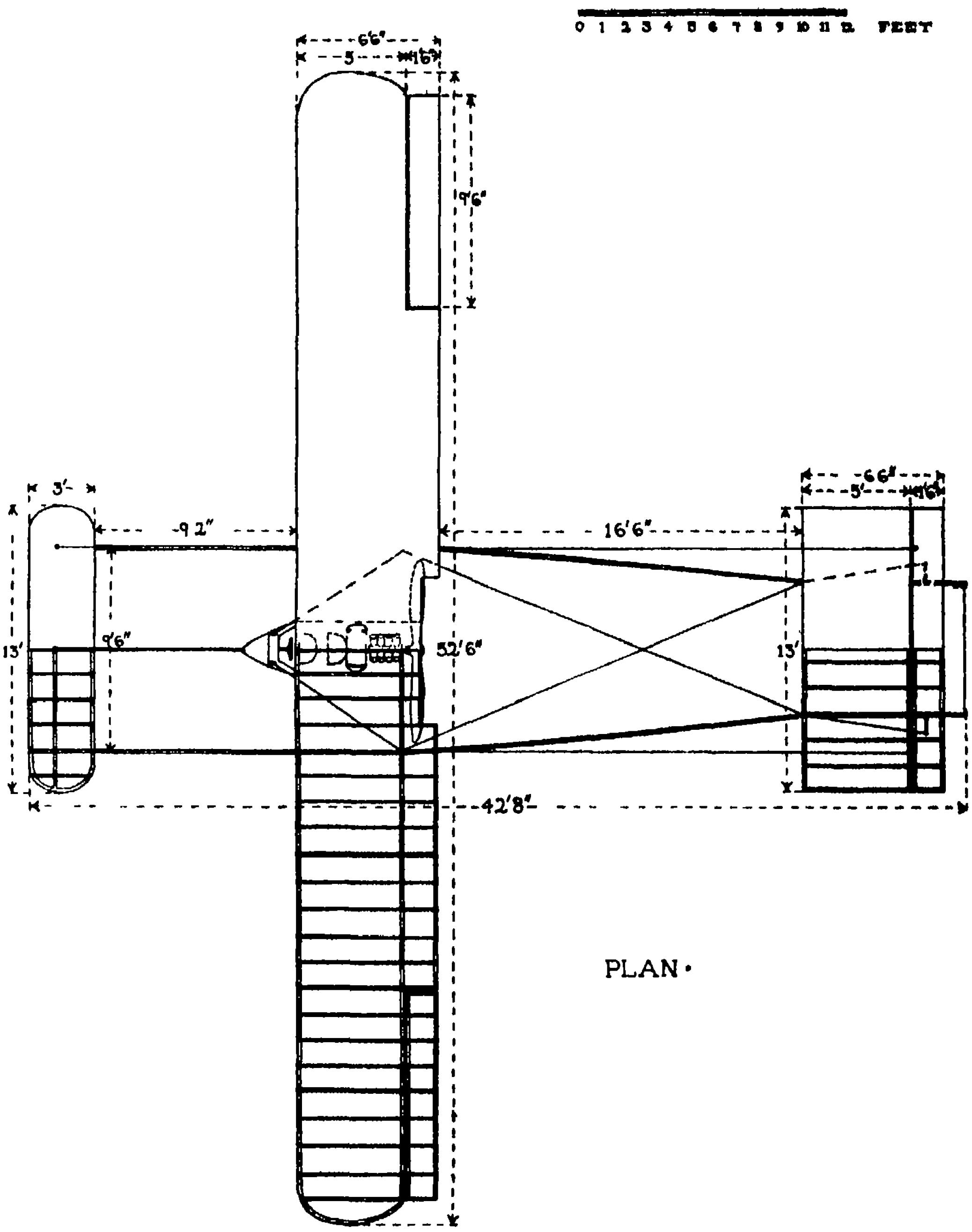
so that at a normal engine speed of 1 800 revolutions per minute the propeller makes 900

Maurice Farman was the first to use a covered body inclosing the seats and engine Some such construction is now recognized as essential for the comfort of the pilot and passenger In the accompanying sketch of the control the fabric inclosing the body is not shown for the sake of clearness On the dash board are placed a gradient indicator a timepiece an aneroid barometer and a recording barograph The handwheel is mounted on a square shaft which slides on rollers at the forward end Forward and backward motion of the shaft alters the angle of the elevator and rotation of the handwheel controls the rudders The pedals work the ailerons

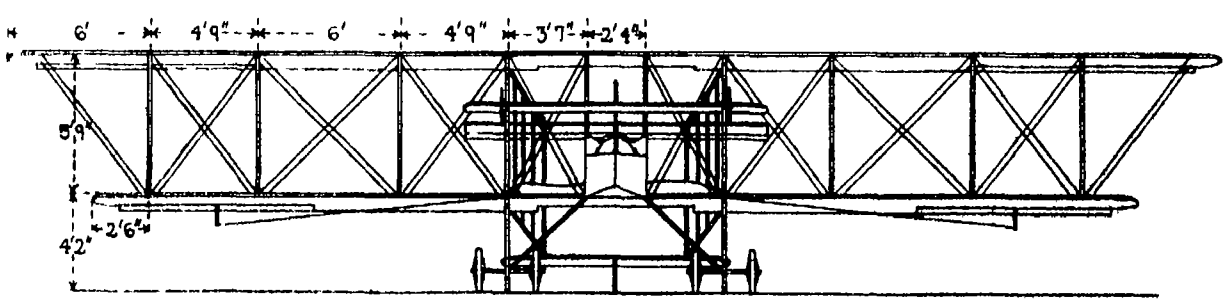
On October 28th 1910 Maurice Tabuteau on a Maurice Farman machine broke the world's record (244 miles in 5 hours 3 minutes 5 seconds) by a flight of 290 miles in 6 hours 1 minute 35 seconds Later Henry Farman captured the duration record (making it 8 hours 12 minutes) and Legagneaux the distance record Tabuteau recaptured the distance record on December 30th by a magnificent flight at Buc of 365 miles in 7 hours, 48 minutes 31 seconds



• SIDE ELEVATION •



PLAN •



FRONT ELEVATION •

thereby winning the Michelin cup for the longest flight of the year

The greatest triumph of the Maurice Farman machine is the winning of the prize of 100 000 francs offered exactly three years before by the Michelin brothers On the morning of the 7th of March Renaux and Senouque left Paris for the summit of the Puy de Dôme mountain 235 miles distant. They reached their destination in 5 hours, 10 minutes 46 seconds including a stop of 14 minutes at Nevers. This achievement marks an epoch in the history of aviation, as it is the first successful long cross-country flight with a passenger made in less than six hours It demonstrated the possibilities of the aeroplane for the rapid transportation of passengers from point to point, and without doubt before the summer is over we shall see aeroplanes regularly used for this purpose

On the need of the aviation world of a grand prize for a stupendous feat, the Michelin brothers—France's great tire manufacturers—based their $20,000 prize three years ago. The great flight they proposed was one of 223 miles from Paris to the Puy de Dôme mountain, a 4,812-foot peak located near their works at Clermont Ferrand The aviator must carry a passenger and make the flight within the elapsed time of six hours, circling the Arc de Triomphe at Paris at the

and turning about the steeples of the cathedral of Clermont-Ferrand before the finish As the summit of the mountain afforded a very constricted landing place, it was generally supposed that an aviator attempting to land upon it would demolish his machine and perhaps be killed or seriously injured and consequently a month or two ago the Michelins attempted to modify the rules to read that a safe landing must be made without breakage of the machine This modification was not allowed but Renaux fulfilled it nevertheless.

At the time the Michelin prize was offered the best records abroad were for height 12 meters (39 4 feet) made by Blériot in August, 1907 and for distance and duration 2 004 meters (6 575 feet) and 3 minutes and 39 seconds respectively (made on March 21st, 1908—two weeks after the trophy was offered—by Henry Farman) As for carrying a passenger this had never been done, even by the Wrights in America So improbable did it seem to the donors that the feat their prize called for could be accomplished that they allowed a period of ten years in which it could be won

The marked advance in aviation in 1909 and the far greater and more rapid progress made last year caused two attempts to be made last summer One of these —that of the Morane brothers in their Blériot monoplane—resulted in an accident soon after the start owing to a reserve can of gasoline breaking loose and interfering seriously with the steering gear The monoplane plunged to the ground and the two brothers were both badly injured The other attempt by Weyman a young Haitian in his Henry Farman biplane was much more successful Weyman getting within fifteen or twenty miles of his destination but being compelled to descend on account of night setting in after he had lost his way and made several descents *en route* in the fog

The first of last month Weyman with his Henry Farman biplane and Renaux with a similar Maurice Farman machine began practising making long glides from heights of 1 000 feet or so and alighting upon a small marked-off spot Next they perfected themselves in alighting upon such a spot with a passenger

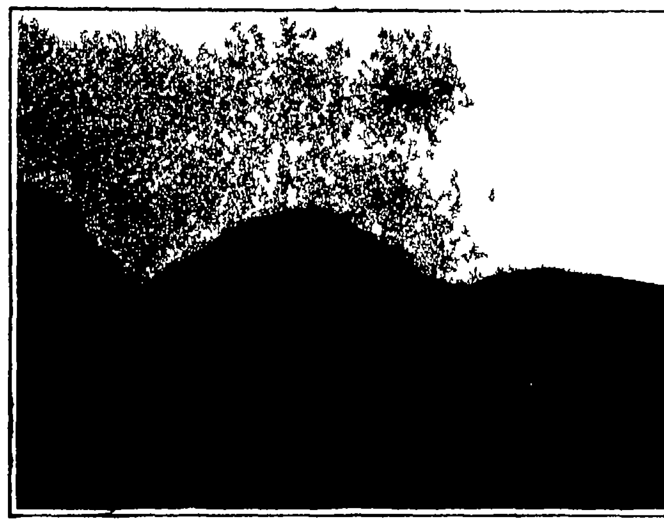
On Monday March 6th Renaux was ready to attempt the great flight, but weather conditions at the P y de Dôme were not favorable The next morning however word was received that the air was clear with no wind As there was only a light and favorable northeast breeze blowing at the aerodrome at Buc Renaux got out his machine and climbed aboard with his passenger M. Senouque He left the ground after a short run at 8 50 A. M and flew to the Aero Club park at St Cloud where he crossed the starting line at 9 12 34 2/5 Heading straight southward he flew above the aerodrome of Juvisy at 9 28 Fifty minutes later he passed over the railway station at Montargis and flew down the line at an elevation of 1 000 feet overtaking and beating an express train. In another hour he crossed Cosne at high speed and at 11 30 La Charitié at a height of 600 feet. A quarter of an hour later the machine was sighted by the great crowd that awaited it at Nevers, where Renaux had planned to alight and take on fuel After circling gracefully about the cathedral of St Cyr the aviator alighted upon the aerodrome of the Lone Poplar at 11 53 30 His time for this first stage of the journey (141 5 miles) was 2 hours 40 minutes 55 3/5 seconds and his average speed about 52¾ miles an hour He reported heavy wind gusts near Briare, but the favorable wind had enabled him to maintain a high speed

After a stop of about a quarter of an hour for luncheon, Renaux re-started at 12 07 37 P M In an hour and a quarter he reached Moulins. An immense crowd awaited him in the country thereabout. He flew over the city at a height of 1,800 feet and M Senouque waved to the people that all was well. Following the valley of the Allier he soon reached Gannat (1.37 P M.), and at 1:53 the biplane was above Riom and almost at its destination.

At Clermont-Ferrand when the town clock struck 2 the great crowd assembled about the cathedral and up in its spires gave a cheer as those at points of vantage were able to discern a gray speck on the horizon Plainer and more distinct it grew and larger and larger as it approached at a height of 1 600 feet or more Fourteen minutes lat r the biplane passed over the cathedral spires amid tumult ous applause and turning sharply headed for the Puy de Dôme which was dimmed by a light fog In 13 min tes ore it ascended some 3 500 feet cir led about and descended easily upon the spot prepar d for it whi h was only a few square yards in size and was marked by wide red bands on the rocky ground Af er a n ag ifice t *vol plané* the biplane alighted easily and Renaux stiff with the cold was helped from his seat.

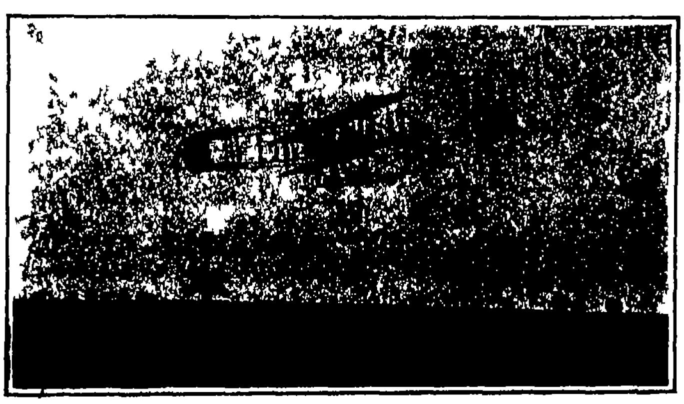
In describing his trip M Re aux said that soon after the start from Paris he suffered with cold and with cramps in his stomach So hard did he have to work at his controls to maintain equilibrium and so badly did he feel that when he reached Montargis he almost made up his mind to descend. Luckily however the fog dissipated and the weather improved giving him new courage and causing him to keep on his way His companion, who was busily engaged studying the map encouraged him by nods of his head Near Cosne they came upon the riv r Loire and for the rest of the journey they followed this and the Allier and had no difficulty in finding their way Nevers was reached and the stop made for replenishment of fuel and for luncheon as told above On e nore on his way Rena x had s m d bts of l is a o sl g l j r ey l 5¼ hours time as he lad b t h s f iends h wo ld do if he had good lu k a d g o l w a h H wonder d if the Puy de Dôme wo d ever show i self on the hori zon He was look ng anx o s y for the m ntain and finally at Gannat 28 mi s away he dis overed t He then began to l l f o 2 0 to 5 900 fee estimating hat this h ght wo d be necessary i order to les e d u the su nn it of he mo ntain At Rio h saw loo u t e dis a he spi s of the c thedr l whi h were his last t rn g poi t In less than t n n inu es th n a l was above Clermont a d he was withn t n min tes of his goal He wondered if l ke the unfortuna e Chavez he wo ld pay with his life for the g gantl l ory he had all but ac omplished He had been c imbing ti uously and now found himself at too high an elevation At this mon ent he was at Braq e at the fork of the roads which lead t Moreno and to Ceyssat He de sc ded again little by l ttle as he approached the sum n it Finally at just the right distance he cut off the spark and g ded n agnifice ly to the summit of the fa no s P y de Dôme

The distance c vered i the first stage of this flight that is from St C o d to Nevers was about 141½ miles whil he balan e of he journey to Clermont Ferrand and the P y de Dô ne was 93½ miles The first half of the jo rney was overed at a higher speed on ac ou t of the wind w h h was favorable The last half was overed a an average speed of 41 1/3 miles an ho r the time in flight bei g 2¼ hours The total e aps d t me was 5 hours 1 min tes 4 ½ se onds Deducting the stop at Nevers the total time in flight was 4 hours 56 minutes 38 3/5 seconds which corresponds to an average speed of 49¾ miles an hour—a remarkably high average considering the amount of climbing' that was done during the trip It will thus be seen that the journey was accomplished with 50 minutes to spare as the time allowed for the flight was 6 hours.



THE BIPLANE APPROACHING THE PUY DE DOME

The observatory can be plainly seen on top of this 4 813 f t n ain



MM RENAUX AND SENOUQUE STARTING ON THEIR 235 MILE FLIGHT FROM PARIS TO THE PUY DE DOME

THE BIPLANE GLIDING TO THE SUMMIT OF THE MOUNTAIN

The Chemistry of Inks in Handwriting*

Things the Expert Must Know

By C Ainsworth Mitchell, B A (Oxon), F I C

Before giving an account of some applications of chemistry in the direction of the general principles underlying the chemical methods of distinguishing between different kinds of ink in handwriting I may perhaps be allowed briefly to recapitulate the main outlines of the theory and to add some details by way of illustration

Ordinary writing ink is essentially a mixture of a decoction of galls with a solution of copperas (ferrous sulphate) which slowly interact to form an iron tannate that gradually becomes oxidized by exposure to the air and gives the black pigment of handwriting

Characters written with a pure iron gall ink are nearly colorless when first put upon paper and a considerable time is needed for the insoluble black tannate to be formed within the fibers

Prior to about the end of the eighteenth century inks were exposed to the air or boiled so that a partial oxidation might take place within the fluid and thus give some depth of tint to the product before it was used for writing The chief objections to such partial oxidation are that deposits are formed in the bottle and prevent the ink flowing smoothly from the pen and that the fluid has not the penetrating power of an unoxidized ink Such inks however are still on the market under the name of Japan inks but they are but little used their place having been taken by unoxidized inks in which the black pigment is as it were in a latent condition and a second pigment such as indigo logwood or an aniline dye-stuff is added to give a color to the writing pending the formation of the iron tannate

The dye-stuffs employed in the commercial inks of to-day vary in color from pale greenish blue to indigo and deep violet and no two give identical reactions—at all events when mixed with iron tannate to form the pigment in writing It is mainly owing to the differences in these provisional coloring matters that it is possible to distinguish between handwriting written with different kinds of ink

In the old type of iron gall ink in which no such second pigment was used it would only have been possible to distinguish between different makes of ink in handwriting in exceptional cases such as when a large excess or a great deficiency of iron had been used Such irregularities in composition might readily occur however for in the days before the ink manufacturer could have made a living writing was a polite accomplishment restricted to those who could afford the time and the ink was made at home Each housewife had her recipe for making a good ink and its preparation was as much within her province as the making of cordials or the baking of bread

A particularly interesting example of a domestic recipe which was handed down as an heirloom is shown in the accompanying figure which Mr G Weddell has kindly allowed to be reproduced

This was taken from a manuscript collection of old family recipes dating back into the sixteenth century which Mr Weddell has published in facsimile (*Arcana Fairfaxiana Manuscripta* 1890) Directions are given for making everything needed for household use from apple pastes to cures for the kings evil and among its odd assortment of items are included several recipes for making ink of which the example (Fig 1) which was probably written toward the close of the sixteenth century is typical

The directions here given are to soak five ounces of galls in one quart of rain water (or claret or red vinegar) and to boil the decoction after five days standing with four ounces of copperas and three ounces of gum

Ink made under the rule-of-thumb methods of the housewife must inevitably have often varied widely in composition and it is to such variations from the right proportions of iron to galls that we must attribute the want of permanency of some relatively modern writings as compared with that upon manuscripts centuries older

No more interesting illustration of this effect of composition of ink upon the permanency of writing can be found than in the various names written on the first page of Miltons family Bible to be seen in the British Museum It will be noticed that all the entries of the births of himself and the members of his family are in the handwriting of Milton and that with one exception all the inks are of a good dark tone The exception is seen in the entry of the birth of his daughter Deborah on the 2nd of May being Sunday, somewhat before three of the clock in the morning 1652 Here the ink has faded to a faint brown color

Considerable variations are possible in the proportions of iron to gallotannic acid without changing the nature of the resulting black pigment but if there is a deficiency of tannin outside those limits insufficient

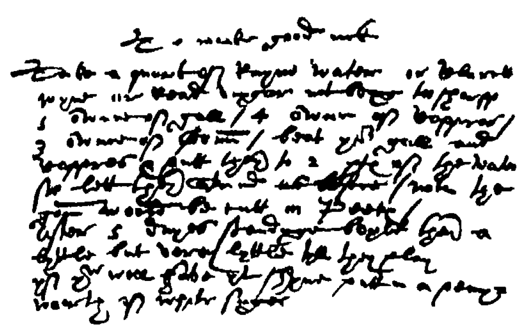


Fig 1—Elizabethan Domestic Recipe for Making Ink

pigment will be formed and the excess of iron will cause the writing to turn brown A lack of tannin to combine with all the iron in the ink is probably the explanation of this faded entry in Miltons Bible

The actual pigment formed when ink dries seems to be the same whether the proportion of tannin to iron be large or small The writer has made numerous analyses of the deposits produced when solutions of the two substances of varying strength were allowed to stand in contact with the air and has found them to contain from 5 4 to 6 2 per cent of iron

Of the known insoluble iron tannates the one that best corresponds with this proportion of iron is that described by Wittstein (*Jahresb der Chem* 1848 28

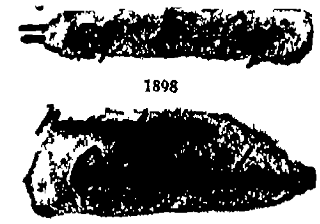


Fig 2—Showing the Action of Oxalic Acid on Inks Written in 1898 and 1908

221) and by Schiff (*Ann Chem Pharm* 187 175 176) which contains 5 3 per cent of iron and has the formula

$$Fe\,(C_{14}H_9O_9)_2$$
$$|$$
$$Fe\,(C_{14}H_9O_9)_2$$

It is probably this compound that is produced when ink dries on paper and that the more nearly the proportions of galls and iron sulphate are calculated to form this tannate without excess of either ingredient the more permanent will be the writing

Many of the commercial inks of the present day deviate widely from this standard and as everyone must have noticed the writing done with some of them

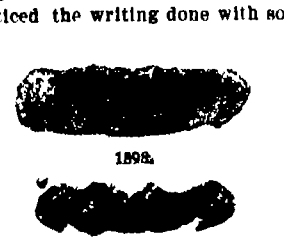


Fig 3—Showing the Action of Acetic Acid (50 per cent) on Inks Written in 1898 and 1908

will fade considerably even in the course of a year or two

Notwithstanding the probably closely similar methods of preparation the composition of different kinds of ink shows wide variations Thus, out of twenty four different varieties of writing ink sold in this country the writer has found the total amount of solid matter to vary from 1 89 to 7 94 per cent the ash from 0 42 to 2 52 per cent, and the iron from 0 18 to 1 09 per cent

Analyses made by the writer at intervals of three or four years have shown that the composition of the products of the same manufacturer shows but little variation This is only what was to be expected, since naturally when a satisfactory article has once been obtained great care is taken to keep it constant by using the same proportions of water, galls, dye-stuff and gum

In examining writing to ascertain whether it was done with a particular ink it is advisable to prepare a color scale with that ink consisting of four washes, ranging from the faintest to the darkest possible tone, and to leave this exposed to the air for at least twenty four hours The scale may then be compared under the microscope with different parts of the writing in question and is subsequently used for comparative chemical tests when such are permissible The broad surfaces of color are comparable with the surfaces of the written characters as seen under the microscope and there is thus obtained what practically amounts to a magnified record of the microscopical appearance

Lovibonds tintometer will also be found useful in comparing the colors of different specimens of handwriting and in matching the colors obtained in chemical reactions with those given by the color scales prepared from known or suspected inks

In some cases microscopical examination on these lines is sufficient to distinguish between the inks in different writings without the necessity of applying chemical tests The most striking instance of this kind within the writers experience was in the Brinkley poisoning case The will of an old lady named Blume had been forged by Brinkley who on the strength of being her heir took possession of all the property Mrs Blumes relatives contested the validity of the will and Brinkley had therefore to prove that it was genuine One of the witnesses whose signatures were on the will asserted that he had never signed a will at all but that he had only signed a folded sheet of paper in a public house As this witness Parker stood in the way Brinkley attempted to poison him by leaving a bottle of stout containing prussic acid at his lodgings but instead of Parker getting the stout it was drunk by his landlord and landlady both of whom died As a great deal depended upon whether Parker were speaking the truth or not the ink was obtained from the public house in question and was compared with the writing upon the will

As the ink happened to contain a particularly bright blue pigment as its provisional coloring matter there was no difficulty in proving its identity with the ink in the disputed signature on the will In fact three different inks were present on this will the body of the document being written in one kind of ink and the signatures of each of the witnesses in a different kind Brinkley cross examined upon this point stated that Mrs Blue had kept three different sorts of ink and that he had after her death given two of them to a little girl

After a trial lasting four days he was found guilty of murder and sentenced to death

For the differentiation of writing by chemical methods a wide choice of reagents is available but the following will usually be found sufficient (1) Hydrochloric acid (5 per cent solution) (2) oxalic acid (5 per cent solution) (3) stannous chloride (10 per cent solution) (4) nascent hydrogen (50 per cent HCl with zinc), (5) bromine (saturated aqueous solution) (6) bleaching powder (saturated solution), (7) titanous chloride, and (8) potassium ferro-cyanide (5 per cent solution containing 1 per cent of HCl)

Of these reagents the first two act mainly upon the iron tannate and leave the provisional coloring matter The third and fourth bleach the iron tannate and reduce the provisional pigment, changing its color The fifth and sixth reagents may act upon both pigments and cause more or less bleaching The titanous chloride acts as a powerful reducing agent on both pigments and the acidified ferro-cyanide solution acts mainly upon the iron liberated from the iron tannate

The reagents should be applied with a brush, and the writing examined under the microscope by reflected and transmitted light, firstly after five minutes', and then after twelve hours exposure to the air The colorations appearing on the wrong side of the paper are also characteristic in some cases In the tests with titanous chloride, blotting paper should be applied to the writing after the lapse of five minutes

The method may be illustrated by the following,

* Knowledge

results obtained with some of the best known commercial writing inks.

The question of determining the age of an ink in writing is much more difficult than that of deciding whether two writings are in the same or in a different kind of ink.

It is, as a rule, possible to distinguish colorimetrically between freshly written and old writing up to about the sixth day after which the iron tannate has become sufficiently oxidized to prevent further differentiation until after the lapse of two or three years or more when the provisional pigment will have faded or have become fixed by the iron tannate.

In most cases the provisional pigments employed offer greater resistance to the action of chemical reagents but are infinitely less stable than iron tannate when exposed to the action of light and of air and eloquent testimony to this difference is given by a comparison of certain manuscripts of the seventh and eighth centuries with typewritten documents in aniline ink which have been put aside for a few years.

Thus it happens that when writing done with blue black ink is kept the blue pigment will gradually fade out, leaving the black pigment, and when this stage is reached the ink in old writing is readily distinguished from ink that has recently been put on the paper.

Prior to this however the blue provisional coloring matter appears to become enveloped in particles of the oxidized iron tannate so that it no longer reacts rapidly with reagents.

Thus if a writing done within the last year or two be treated with a fifty per cent solution of acetic acid there is immediate diffusion of the blue pigment whereas in a writing a few years older diffusion if it takes place at all is very slow and limited in extent (see Fig 3).

A still more useful reagent is a saturated solution of oxalic acid which causes the pigment of relatively fresh writing to give an immediate smudge but has very little if any effect on writing six or eight years old. The differences between the behavior of old and relatively new writing in these tests is seen in Fig 2 in which the older writing of 1898 was scarcely affected whereas the writing done in 1908 gave the results shown. Both writings were in ink of the same kind and the tests were applied simultaneously.

Speaking generally a writing done with blue-black ink ceases to show such diffusion after about five to six years. When slight diffusion occurs in an older ink it is seen under the microscope, to differ in character and only to affect the surface of the letters whereas the diffusion in an ink written within the last two or three years affects the whole of the pigment in the letters.

The first occasion on which chemical evidence as to the age of an ink has been given in the law courts was in the recent forgery case in which Colonel Pilcher was accused of forging his cousin's will.

This will was alleged to have been written in 1898 and assuming this to have been the case the ink should have only reacted very slowly with the different reagents there should have been little or no diffusion with oxalic acid and if any slight diffusion occurred this should only have been upon the surface of the letters.

The ink on the will however gave an immediate reaction with the different reagents and diffused at once with oxalic acid and the diffusion extended throughout the whole of the letters. There was thus no doubt as to the ink upon the will having been written within the last year or two and certainly within the last six years.

Checks written by the deceased lady during the last thirteen years were also subjected simultaneously to the same tests and it was found that the ink upon those written in 1903 gave only a faint diffusion with oxalic acid in the heaviest writing while no diffusion at all was obtained upon the checks written in 1901.

The correctness of the conclusions drawn from these results was borne out by the confession of the prisoner who in the middle of his trial pleaded guilty to having uttered the will knowing it to be a forgery though he denied all knowledge of how it came to be forged.

COLORATIONS FIVE MINUTES AFTER APPLYING REAGENTS

Inks.	Hydrochloric Acid	Oxalic Acid	Stannous Chloride	Nascent Hydrogen	Bromine	Titanous Chloride	Potassium Ferrocyanide
Blackwood's	bright blue	bright blue	bright blue	deep blue	deep blue	green blue	bright blue
Draper's	deep violet	red violet	violet	violet	violet black	maroon	deep violet
Field's	deep blue	deep blue	violet blue	violet	deep blue	navy blue	blue
Mordan's	bright blue	bright blue	bright blue	bright blue	dark purple	dark green gray	dark blue
Stephens	deep blue	deep blue	violet	violet blue	slight bleaching	nearly black	deep green blue
Walkden's	bright blue	blue	bright blue	blue	blue	gray blue	dark blue

Notes on the Economics of Locomotive Operation*

The Problems Presented by Increasing Size

By Prof Arthur J Wood

The locomotive is a power plant on wheels. Every year the demands on this plant are more exacting and as a result we find to-day the latest type developing over 2 000 horse-power weighing 445 000 pounds with all the weight on two sets of eight coupled drivers with a Walschaert valve gear compound cylinders superheaters and a hydro pneumatic reversing gear. Contrary to a somewhat common belief the modern locomotive if worked to advantage is an economical machine for what is demanded of it. But the demand for greater hauling capacity has emphasized and enforced the big problem in operation that of securing the most at the track out of a pound of the fuel burned. Let us briefly note some lines of progress leading to a better economy and to a higher efficiency.

THE THREE BALANCED FORCES

Let us be reminded that the locomotive is made up of three essential parts—the boiler the cylinder and the drivers. In this three-fold combination the boiler power is limited by the amount of steam that can be produced in a boiler of admissible size and weight. The cylinder power may be indefinitely great but not less than a certain amount the cylinder being a mere transmitting machine. The tractive power—or pull at the driving wheels—is limited by the total weight of the locomotive and the part of that weight which can be placed on the driving wheels. We have then three co-ordinate balanced forces. In practical working a lack of proper proportion in any one of these three co-ordinate forces which when combined make the completed machine will be shown in the following way. If the boiler power is smallest the steam pressure will fall and the wheels will stop. If the cylinder power is smallest the engine will be stalled when using full steam pressure and unable to slip the drivers. If the tractive power is smallest of the three the engine will slip the drivers. We come to see then that the locomotive is a balanced machine and in any attempt to increase its economy that balance should be preserved. Thus if we increase the boiler pressure and capacity say thirty per cent everything else remaining the same the drivers would be slipping some of the time if they were correctly proportioned before.

THE SCOPE OF THE PROBLEM

It is estimated that 125 000 000 tons of coal (one fifth of the coal production of the entire country) were burned last year on the 60 600 locomotives in the United States. This coal costs the railroads over $360,000,000. If a net saving of five per cent otherwise lost can be secured this item will be reduced by no less than $15 000 000 and will at the same time conserve one of the most valued natural resources of the country. If further this saving can be effected by the utilization of low grade fuels otherwise discarded and burned with more nearly smokeless combustion the results will be far reaching. Possibilities lie along many lines among which are the following. More perfect combustion better smoke box and front end construction by compounding superheating and from briquetted fuel. The first two of the above have general application while the others have given noteworthy results where the conditions were favorable. To these may be added the saving from the introduction of a perfected mechanical stoker eight or ten of which are being tried out. This saving—estimated on certain roads from ten to fifteen per cent—will come largely from the uncontrolled losses due to improper hand firing.

In a recent analysis of the heat losses in a simple locomotive with superheater running on the test plant at Purdue University Dr W F M Goss finds that a little over forty per cent of the heat in the fuel never has a chance to turn water into steam as shown in the table following.

TABLE I

AVERAGE HEAT BALANCE FOR TEST LOCOMOTIVE

(Percentages of total heat available)

Absorbed by the water in the boiler	52
Absorbed by the steam in the superheater	5
	—
Absorbed by steam in the boiler and the superheater	57
Lost in vaporizing moisture in the coal	5
Lost through the discharge of CO	1
Lost through the high temperature of escaping gases and in the products of combustion	14
Lost through unconsumed fuel in the form of front-end cinders	3
Lost through unconsumed fuel in the form of cinders or sparks passed out of the stack	9
Lost through unconsumed fuel in the ash	4
Lost through radiation leakage of steam and water etc	7
	100

The above suggests the grouping together of some of the various means of securing better results indicating under each what is being undertaken.

A.—More complete combustion and better firing	(1) Certain roads notably the Erie the C & N W and the B R & P have been giving regular instruction to firemen in the right methods of firing. (2) Adapting the coal to the best conditions of firing
B.—Saving in losses from stack and front end	Design of self-cleaning front ends and reduction of losses as a result partly of exhaustive tests at Altoona
C.—Adapting locomotive weight to required service and in compounding	Introduction of the Mallet articulated compound locomotives (with all the weight on drivers) and having two independent sets of coupled drivers for mountain grades where one locomotive can do the work of two smaller engines
D.—Reducing high temperature in exhaust gases	Adapting the Schmidt Baldwin Schenectady Jacobs Cole Vaughan Horsey and other superheaters

We may look a little further into these questions.

A COMBUSTION

Approximately 544 000 cubic feet of air are required to supply the necessary oxygen to completely burn one ton of coal; less than this means waste in the form of unburned carbon. Not only must the air be supplied but it must be supplied in the right quantity at the right place. The simple principles of combustion may be studied from the best theoretical furnace on the market, that of the common coal oil or kerosene lamp.

The upper part of the chimney of the lamp corresponds to the stack. The larger part of the chimney is in the analogy the combustion chamber including the front end of the locomotive. The small space just above the wick is the fuel bed and the air openings below are the openings through the grates for air supply.

First remove the chimney open the hood and light the wick which should be evenly trimmed. If turned low it does not smoke. Close the hood and the flame smokes because the hood has cut off the air about the flame thus illustrating a furnace with insufficient air where most needed a condition which occurs when we have too much fuel on the grate.

* Railway Indicator

Second, place the chimney in its right position on the lamp. The smoke ceases and the flame brightens, showing better combustion. This better condition is from the fact that the draft draws more fresh air about the wick just where demanded.

Third chill the flame by means of a piece of iron held in it, thus cooling the gases before combustion is complete illustrating the condition when too much cold air strikes the flame.

Fourth when burning brightly with the chimney on shut off the air supply by wrapping a cloth about the hood closing off the required air supply and the flame smokes as it does when the dampers in the fire box are closed too much.

Fifth break a hole into the side of the chimney or raise it from its seat and the flame is chilled and the lamp smokes as we are admitting air where it is not most needed. Open the fire door of the locomotive and the same thing happens the air being chilled before combustion has been completed.

From these simple experiments, which any reader can make we learn that the conditions for preventing smoke and securing better fuel economy are

1 That the fuel be supplied in small quantities and just enough air be passed up through the grates to burn it

2 That the gases be distilled from the coal at a uniform rate

3 That the air be heated by passing through the bed of hot coals

4 That the volatile gases given off shall mix with the fresh supply of air so that each particle of the carbon elements gets its necessary supply of air

It is understood that smoke comes chiefly in the burning of bituminous coal. The losses in black smoke are not large scarcely ever exceeding one per cent of the heat in the fuel. A furnace working with a minimum air supply may give out dense clouds of smoke but still give a higher evaporation than one made smokeless by an excess of air. Consequently smokeless combustion is only an indication of conditions in the fuel bed and is a very small part of the question of fuel economy. The simple principles of combustion should be well understood by every fireman, and their application be enforced by more systematic instruction. While it is true that locomotives in poor condition are often turned over to the engine crew and they are expected to get results with poor fuel yet the evil from improper handling of the fuel is by far the greater of the two.

Special Fuels.—The kind of fuel—its chemical composition its size friability ash and moisture—also influence economy. In one of many results using Lloydell raw coal and the same coal pressed into briquets being held firmly intact by aid of a binder (see Bulletins 412 and 363 U S Geological Survey), it will be seen that the briquets gave ten to fifteen per cent higher evaporation than with run-of mine coal from which the briquets were made. It has been shown that steam can be kept up easier with the briquets but the disadvantage comes from decreased storage capacity in the tender difficulty in shoveling and last but not least difficulty in firing.

Road Tests of Briquets.—In co-operation with the Missouri Pacific the Lake Shore and Michigan Central the Chicago Rock Island and Pacific the Chicago Burlington and Quincy and the Chicago and Eastern Illinois railroads 100 locomotive tests have been made for the United States Geological Survey to determine the value as a locomotive fuel of briquets made from a large number of western coals. All tests were made on locomotives in actual service on the road. In some tests there was small opportunity for procuring elaborate data, but in others, where dynamometer cars were employed it was possible to obtain more detailed results. In nearly every test, the results reported show that the coal when burned in the form of briquets gives a higher evaporative efficiency than when burned in the natural state. For example, Indian territory screenings gave a boiler efficiency of 59 per cent, whereas briquets made from the same coal gave an efficiency of 65 to 67 per cent. Decrease in smoke density and in the quantity of cinders and sparks are named as the chief reasons for increased efficiency.

Similar comparative tests in 1907 on the Atlantic Coast Line showed a saving of 20 per cent in the pounds consumed per car mile and with the elimination of black smoke and clinkers. On the W and L E a gain of 16 per cent was secured in ton miles hauled by using three-fourths coal instead of run of mine the former costing 8 per cent more at the mine. Development lies in the direction of making it possible to use to advantage the low grade fuels and in this the briquets have just begun to open up a new field. The cost of briquetting is roughly $1.25 per long ton.

B FRONT END LOSSES

Referring to the table by Prof Goss, we find that in his tests 12 per cent of the heat of the coal is lost in the front end cinders, and in cinders and sparks passing out of the stack. To correctly design the smoke box, a long series of tests were made three years ago on the Altoona plant with an Atlantic type locomotive of the Pennsylvania Railroad. Approved forms of a self-cleaning front-end arrangement were designed as an outcome of this series of tests. A study of this result compared with the Master Mechanic's front-end design shows a change in the relative proportions of the stack, the exhaust nozzle and the diaphragm plate, the result being much better evaporation in the class of locomotive tested over the same class with the old arrangement in the front end.

C ADAPTING LOCOMOTIVES TO SERVICE.

Another way of effecting economy in operation lies in adapting the train load and speed to the particular engine best suited to meet the conditions. The most marked advance attracting attention and interest in this particular is in the adoption of the Mallet articulated compound locomotives. An articulated locomotive is one composed of independent cylinder and driving wheel units "tied together at a joint." One example of economy by using an engine of this type is on the Delaware and Hudson Railroad. Four runs were made the past summer with two pushers of the E-5 class, 2-8 0 type with a total weight 246,500 pounds, 217 500 pounds of which is on the drivers then four runs with one of the Mallet locomotives having 445 000 pounds on the drivers followed by four more with another Mallet. The tonnage of all trains were practically the same. The result showed that the Mallet locomotives did almost exactly the same work as the two E-5 engines with a saving of 40 per cent in coal and 27 per cent in water.

D. LOCOMOTIVE SUPERHEATERS

A superheater is a device whereby additional heat may be applied to the steam after it has been evaporated by the boiler. The advantage comes in (1) reducing or eliminating cylinder condensation, (2) increase of available temperature range of expansion without increase in pressure and (3) the large increase in steam volume with a comparatively small increase in heat to superheat.

In 1901 the Canadian Pacific introduced the use of superheated steam on locomotives in America and nearly 500 Vaughan Horsey superheaters are now in service on that road. The Atchison Topeka and Santa Fe with 168 locomotives thus equipped, comes second in the list of twenty roads in this country now trying out a total of eight types of superheaters. The Schmidt superheater is used on 130 railroads in Europe applied to over 5 000 engines. The adoption of superheaters in this country has on the other hand been along more conservative lines notwithstanding the fact that nearly all the roads using them report a material saving in coal and at least half the number find no increase cost in running repairs. The most serious trouble experienced has been in leaky gaskets and filling of front end and flues with cinders.

The question of the amount of superheat is a most important one. The Purdue tests have shown that the first 80 to 100 degrees superheat do not make the same proportional decrease in coal consumption as do the second 80 or 100 degrees. European practice is to superheat until the temperature is 500 to 600 deg F or over in fact, as high as possible and still maintain good lubrication with forced lubrication for the balanced piston valves. This general practice applies to simple and to compound locomotives in both cases the attempt appears to be to prevent condensation in the cylinder. This makes an expensive construction to maintain and it has not met with favor.

Recently tests were run on a tandem compound, 2-8-0 type of the Atchison Topeka and Sante Fé Railway equipped with high and low pressure superheaters versus the same class of engines without superheating. Both superheaters are in the front end the low pressure superheater being directly ahead of the front flue sheet and the high pressure in front of the low pressure superheater, both being designed so as not to obstruct the flow of the gases more than necessary. In the following summary the first column gives the results for the locomotive with the superheaters.

Mr H B MacFarland, engineer of tests of the Santa Fe Railroad, has drawn the following conclusions from those made.

1. "There is a marked decrease in coal consumption for a superheater engine. The decrease averages 20 8 per cent per thousand ton miles for up-grade runs, 11 5 per cent for down grade runs, and 19 6 per cent for constant hard working of engine on heavy grades."

2. "Superheater engine uses 10 per cent less water per hour, developing more drawbar horse-power on heavy working."

3. "Superheater engine with 16.6 per cent less heating surface gives equivalent evaporation of 10 6 per cent more water per square foot heating surface than non-superheater engine."

4. "Superheater engine developed 30 per cent more draw-bar horse-power per square foot of heating surface than non-superheater engine."

TABLE III.

	Superheater.	[illegible]
Engine Number	[illegible]	[illegible]
Cylinders, inches	[illegible]	[illegible]
Speed M. P. H	[illegible]	[illegible]
Train tonnage	[illegible]	[illegible]
Pounds of coal per thousand ton miles	[illegible]	[illegible]
Steam per hour per sq. ft. heating surface	[illegible]	[illegible]
Pressure, pounds per square inch:		
Boiler gage	[illegible]	[illegible]
High-pressure superheater	[illegible]	..
Low-pressure superheater	[illegible]	
Quality of steam per cent		
At dome	[illegible]	[illegible]
High-pressure exhaust	[illegible]	
Superheat degrees Fahrenheit		
Leaving H. P superheater	[illegible]	
Leaving L. P superheater	[illegible]	
Equivalent evaporation from and at 212 degrees Fahrenheit:		
Per sq ft, heating surface per hour	10 [illegible]	[illegible]
Per pound of coal	8.[illegible]	[illegible]
Indicated horse-power:		
H P cylinders.	416 0	[illegible] 0
L. P cylinders	[illegible] 0	[illegible] 0
All cylinders	1,[illegible].0	1 1[illegible]
Boiler horse-power	1,1[illegible] 0	[illegible] 0
Boiler efficiency per cent	[illegible]	[illegible]

Mr MacFarland informs the writer that the cost of equipping engines with the superheaters used in the tests is $898 of which $750 is for the superheater, $75 for applying the same and $73 for cutting off the flues and setting the flue sheet back. If we assume the cost complete of a locomotive of this type and class as $15,000 the cost of applying superheaters is approximately one-seventeenth of the first cost. The Atchison Topeka and Santa Fé Railway is having certain engines equipped with low pressure superheaters only. These will be run in service to determine if this is the most satisfactory arrangement of installation in order to get for this and others the net economy with front-end superheaters for many conditions.

The study of this question on the Santa Fé is the most important investigation of the superheater equipment for compound locomotives undertaken in this country. Assuming 450 deg F as the maximum temperature allowable in the steam chest, the present development as being worked out is much more attractive than any of the methods requiring excessively high temperatures.

From the data given the writer has plotted a temperature-entropy diagram. To any not familiar with this diagram it may be stated the areas represent heat units expressed in B t u. In the original of this particular diagram 1 square inch equals 10 B t u. Knowing the number of B. t. u. in a unit area we may readily determine the heat change represented along any line. This is all we need to know to understand its application to the problem in hand.

Fifty-eight and sixty-one-hundredths B t. u. per pound of steam equals work done in high-pressure cylinder which is less than one-half of the amount of work done in the low pressure cylinder. The same fact is shown from the horse-power results given in Table II. The work could have been more equally divided by changing the cut-off in the low pressure cylinder. In stationary practice it is common to divide the temperature range equally between the high and the low. This would have given a better distribution in the case at hand.

We conclude (1) that a small amount of superheating in the high pressure cylinder is of little or no advantage, (2) when the pressure drop is large between the cylinders large gain is effected by a considerable superheat in the low pressure cylinder, (3) for the same amount of heat in the superheat (in the case considered) we could theoretically gain less in heat transformed into work by using the two superheaters than we could by the same amount of heat in one high pressure superheater, but this requires the objectionable high superheat, and (4) superheating to 100 degrees or over for the low pressure cylinder is, theoretically an attractive proposition, the practical results of which will be learned later with interest.

It must be understood that actual conditions on a locomotive will not correspond exactly with the conditions which have been taken in this study. For example, the writer has assumed adiabatic expansion. Actually, it is modified by cylinder condensation, but since it was considered the same in all cases the results may fairly be compared in the way outlined.

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Mastering the Alaskan Glacier Barriers

By LAWRENCE MARTIN
Professor of Geology University of Wisconsin

GLACIERS have both helped and hindered exploration and settlement in Alaska which we purchased from Russia forty three years ago for a little less than seven and a quarter million dollars We have since removed over seventy million dollars worth of furs especially the seal one hundred and nine million dollars worth of fish especially salmon and one hundred and sixty two million dollars worth of minerals especially gold In accomplishing this men have had to cope with conditions of mountain glaciation to a greater extent than any where else in the world The following paragraphs will narrate some of these difficulties and the ways they have been met

NECESSITY FOR TRAVELING OVER GLACIERS

The Klondike district and the adjacent gold fields in Alaska were separated from the coast by a lofty mountain barrier This could be crossed at Chilkoot and White Passes or the lower Yukon could be ascended The latter route was long and difficult and unexplored the former was also hard and led through Canadian territory Accordingly the prospectors sought a short all American route and found that the head of ocean navigation at the east entrance of Prince William Sound near the mouth of Copper River was nearer the gold fields than Skagway the beginning of the White Pass route They did not count on the range being double however or on the higher passes or the glaciers The lower Copper River valley is barred by three great glaciers projecting from either side and making river navigation impossible Most of the prospectors therefore turned their attention to Port Valdez the northeastern extremity of Prince William Sound Here rumor said that the Russians had a route to the upper valley of the Copper River where gold was also reported Here however canyons and unexplored high passes made a pass in which there was a glacier barrier the only highway to the interior If the Valdez Glacier were not there this pass would furnish the shortest road or railway route to the copper mines of the Wrangell Mountains the coal fields of the Matanuska River and the interior of Alaska. The harbor is the best and takes ocean steamships farthest back into the land In the valley and pass however is a glacier barrier

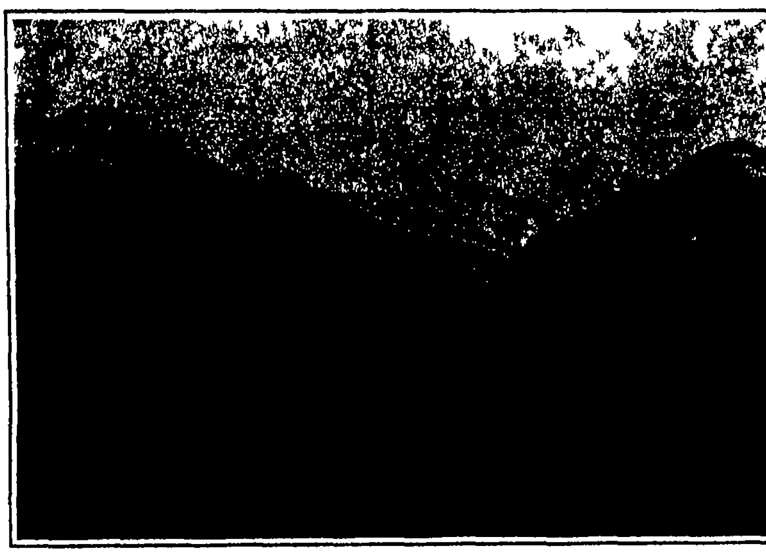
THE GLACIER BARRIERS OF LOWER COPPER RIVER

As already stated the Copper River is apparently the logical highway to interior Alaska Only a few prospectors entered this way in 1898 and 1899 however and army officers had previously shown in 1884 and 1885 that this route was difficult dangerous and impracticable

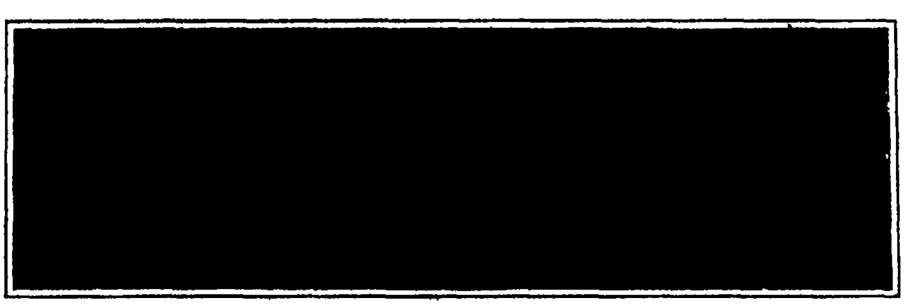
The specific difficulties and dangers occur in connection with the three great glaciers of the lower Copper River There is now no great trunk glacier occupying the main valley as in the case of the valley at Valdez Instead we have three glaciers projecting into the valley of Copper River two from the west and one from the east. These are about 3 miles from the Pacific Ocean They were long known to the natives and to the Russians and were seen and named by Abercrombie and Allen of the United States army in 1884 and 1885 and revisited by the former in 1898 after his trip across the Valdez Glacier highway

Childs Glacier three miles wide projects into the valley from the west ending in a magnificent cliff shown in one of the photographs reproduced here It constricts the river and forms dangerous rapids up which boats can be lined with great labor and danger because of the swift current and the great waves from falling ice masses The river is so retarded that a lake is formed above Childs Glacier in which Miles Glacier terminates

Miles Glacier enters the valley from the east, as shown on the map Part of it projects only slightly from its valley and terminates in a beautiful ice cliff 200 feet or more in height and with a frontage of two and a half miles in the lake into which it discharges many icebergs The remainder of the Miles Glacier terminus which expanded into a bulb in the main valley is a low dark surface five or six miles wide projecting clear across the valley from the east to the west wall and forcing the Copper River into a narrow channel called Abercrombie Rapids At Abercrombie Rapids this dirty part of Miles Glacier has been in

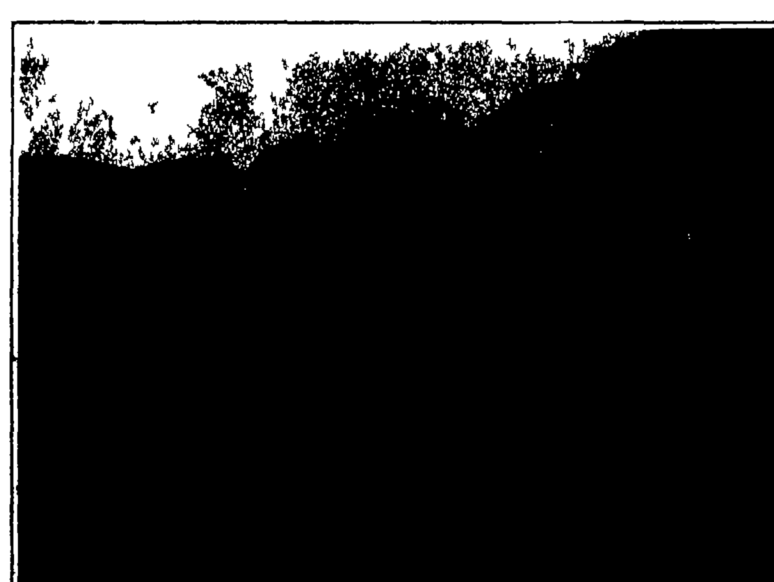


THE VALDEZ GLACIER A BARRIER IN A PASS ACROSS THE CHUGACH MOUNTAINS WHICH WAS TRAVERSED AS A HIGHWAY BY OVER FOUR THOUSAND GOLD SEEKING PROSPECTORS IN 1898



THE MILES GLACIER, SHOWING THE CLIFF THE LAKE, AND THE RAILWAY LEADING TO THE CAR FERRY WHICH WAS IN OPERATION IN 1909 BEFORE COMPLETION OF THE BRIDGE

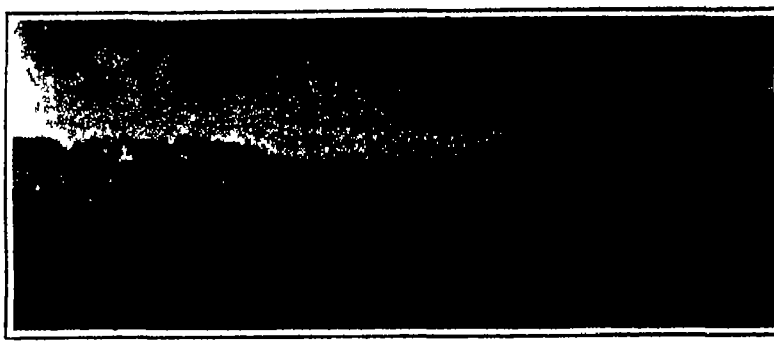
MOUNTAINS OF THE LOWER COPPER RIVER REGION AND CHILDS GLACIER WHICH PROJECTS INTO THE VALLEY, AND WHICH ADVANCED AS SHOWN BY THE DATES 1905 AND 1910



THE TWO HUNDRED AND EIGHTY FIVE FOOT CLIFF OF CHILDS GLACIER TERMINATING IN COPPER RIVER. A FALL OF ICE SPLASHING SPRAY NAVIGATION HERE IS DIFFICULT AND DANGEROUS

MASTERING THE ALASKAN GLACIER BARRIERS

active since some time during the Russian occupation of Alaska and does not look like a glacier at all for its ice is veneered with dirt stones and soil in which a thicket of shrubs has grown At Abercrombie Rapids the river is so narrow and swift that it plunges down in a series of boiling rapids not inferior to those below Niagara It is unnavigable for steamers and small boats are taken through with the utmost labor and hazard



THE MILES GLACIER AS SEEN FROM THE COPPER RIVER THE MOUNTAINS IN THE BACKGROUND ARE 8 000 TO 10 000 FEET HIGH

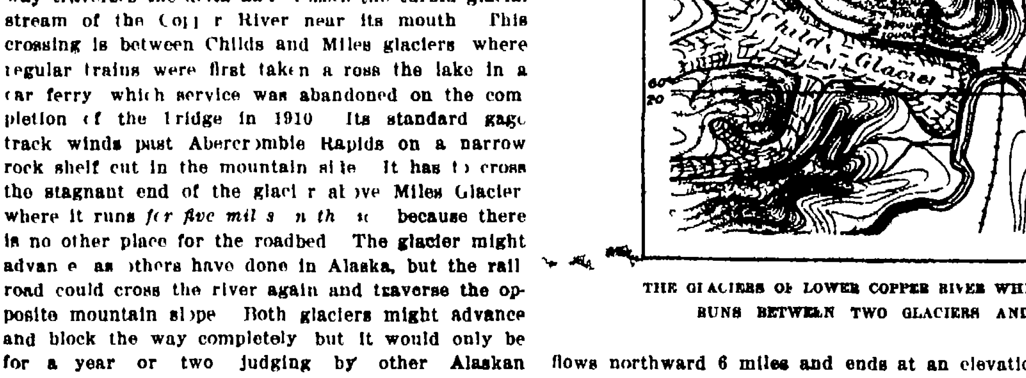
Above Miles Glacier where a third great glacier the Allen projects into the valley this time from the west the Copper River is forced over against the east bank in Baird Canyon by the glacier bulb terminus of which has been stagnant but veneered and tree covered since before 1898 and probably longer

Above Miles Glacier steamers ply on Copper River below the river is unnavigable The glacier barrier is of another sort from that at Valdez but it has effectively prevented the gold seeking prospectors and others since from utilizing the Copper River highway to the interior of Alaska

MASTERING THE GLACIER BARRIERS ON COPPER RIVER

The need of transportation in productive Alaska particularly of transportation for copper ore for coal and of cheaper and quicker access to the interior has interested large capital and one of the first of the great trunk railways in Alaska is being built up the Copper River and at the end of 1909 had successfully mastered the glacier barrier of the lower river reaching the copper mines near Mt Wrangell in the winter of 1911 It cannot start from the mouth of the river which is too shallow for ocean steamships but begins at Cordova at the east entrance of Prince William Sound where one of the future metropolises of Alaska is growing rapidly in a beautiful location The railway traverses the delta and crosses the turbid glacial stream of the Copper River near its mouth This crossing is between Childs and Miles glaciers where regular trains were first taken across the lake in a car ferry which service was abandoned on the completion of the bridge in 1910 Its standard gage track winds past Abercrombie Rapids on a narrow rock shelf cut in the mountain side It has to cross the stagnant end of the glacier above Miles Glacier where it runs *for five miles on the ice* because there is no other place for the roadbed The glacier might advance as others have done in Alaska, but the railroad could cross the river again and traverse the opposite mountain slope Both glaciers might advance and block the way completely but it would only be for a year or two judging by other Alaskan glaciers

The glaciers have been mastered and a permanent highway across the mountains has been obtained It took daring skilful engineering large capital and



PROSPECTORS AT THE SUMMIT OF VALDEZ GLACIER 4 800 FEET ABOVE SEA LEVEL, CARRYING THEIR OUTFITS

MASTERING THE ALASKAN GLACIER BARRIERS

it should be said no cent of government subsidy or land grant We have another scenic route destined to rank with the great American wonderspots of the Grand Canyon of the Colorado the Yellowstone Park and Niagara Falls for nowhere else the world over can one pass between two such glaciers and over the ice of a third in a Pullman car The Valdez Glacier barrier was crossed temporarily, as described below

That of the lower Copper River has been mastered and made a permanent highway to the interior of Alaska until the glaciers advance and destroy it, as several of them might do Such an advance however should be short-lived, and the section of track affected could be rebuilt

THE VALDEZ GLACIER HIGHWAY

From the head of a beautiful fiord Port Valdez a gradually sloping gravel plain leads three and a quarter miles to the terminus of Valdez Glacier 210 feet above the fiord The glacier is 18 miles long and 1 to 2 miles wide and rises in terraces or benches to a height of 4 800 feet where there is a snowy pass from which another ice tongue the Klutena Glacier

THE GLACIERS OF LOWER COPPER RIVER WHICH FORM A BARRIER TO NAVIGATION THE RAILROAD RUNS BETWEEN TWO GLACIERS AND FIVE MILES OVER THE ICE OF THE THIRD GLACIER

flows northward 6 miles and ends at an elevation of 2 020 feet From here a stream flows into Klutena Lake which drains to the upper Copper River In recent years the Valdez Klutena Glacier has been inactive and little broken by crevasses and could be used as a highway by man and horses The end receded 630 feet from 1898 to 1909

THE STAMPEDE TO VALDEZ

In the late winter and early spring of 1898 the prospectors stampeded to Valdez The gold seekers of 1897 had had a hard time crossing Chilkoot and White Passes and this new route which avoided these passes and the rules and regulations of the Royal Northwest mounted police, was eagerly followed, although in complete ignorance of what it promised. It has been estimated that over 3,000 men were landed at the head of Port Valdez in February, March and April, 1898, and one or two thousand in the ensuing months Beside these prospectors there was a United States government party under command of Capt. W. R Abercrombie. It is chiefly from the accounts by Abercrombie and his lieutenants and the geologist F. C. Schrader of the United States Geological Survey that the facts stated below are gathered There has never been in the world s history so wholesale a utilization of an ice-filled pass as a highway as that in connection with the stampede of 1898

TRAVEL ACROSS VALDEZ GLACIER.

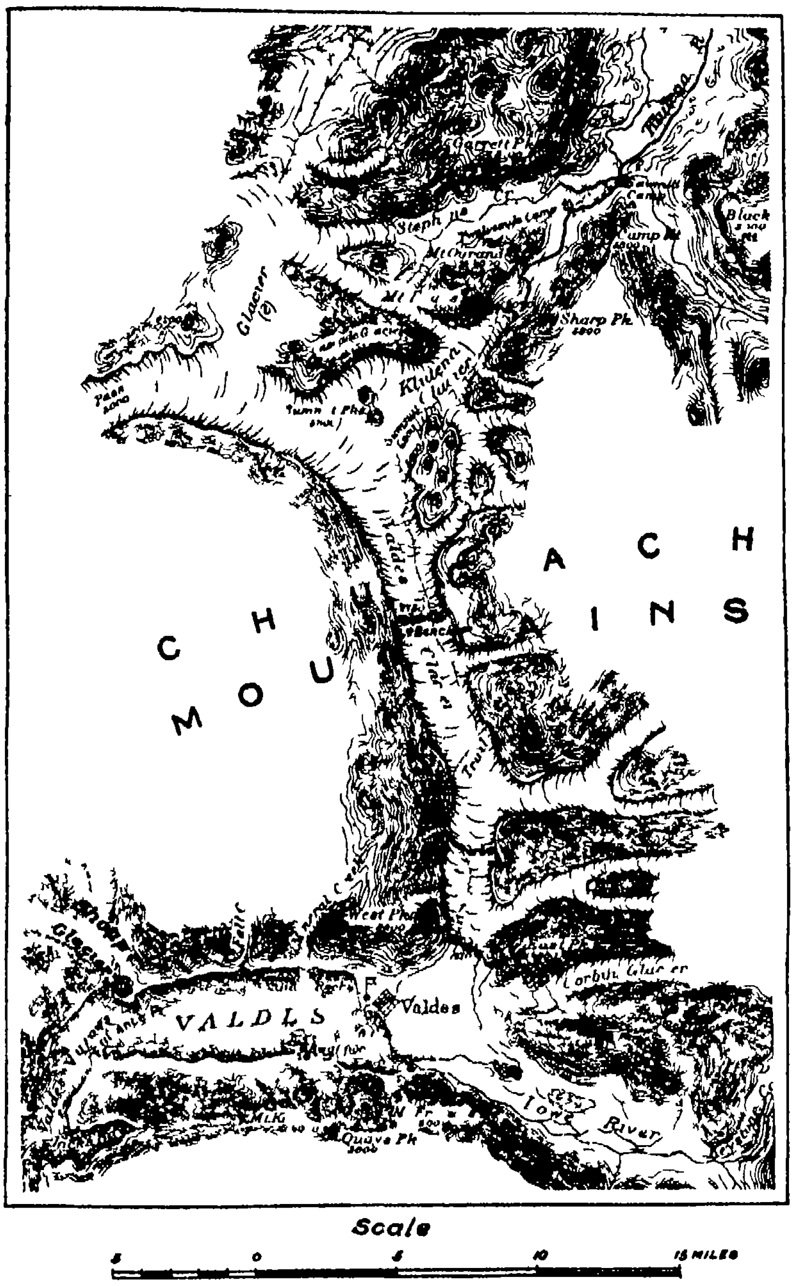
These prospectors were wholly unprepared for travel over ice And when most of them landed at Valdez, they saw a glacier for the first time They had sleds, but almost no other glacial equipment and suffered particularly for lack of fuel and water until experience taught them that wood must be carried or better oil stoves to make fires for cooking and melt snow or ice to get water Few had snow shoes and none had ice axes or glacier ropes especially necessary for rescuing those who fell into crevasses

The trail was crooked for while the glacier was not severely crevassed it was so riven by chasms that the parties had to weave back and forth between crevasses sometimes going three or four miles to advance one mile This was also the case when the writer traversed the lower portions of the glacier in 1904 and 1909 The way was easily lost in a fog or a snowstorm and the many days necessary for traversing this glacier with a heavy outfit of equipment and provisions were attended by great fatigue, discomfort and some loss of life.

Men lived for days upon the glacier chiefly in tents Schrader mentions one trip when he counted camps as follows 300 people at the foot of the glacier near Valdez 100 tents at Five Mile Cache, and 300 or 400 people at Twelve Mile Camp The so-called benches were places of temporary settlement, for here there were steep ascents of one hundred feet or more up some of which the loaded sleds could not be drawn Near the summit there was a rise of 1,000 feet at an angle of nearly 15 degrees or 20 degrees. At such places provisions had to be hauled up by block and tackle or carried on men s backs Glacier villages occupied by the succession of parties and large temporary deposits of provisions and outfit called caches were at the base and the top of this ascent. At such places of delay fuel was in especial demand, and wood brought a dollar a pound

Sometimes it snowed continuously for 120 hours, and tents would be crushed unless shoveled off These caches buried beneath eight to twelve feet of snow could sometimes be found again only by probing with long poles. Large snow slides came down the steep walls of the valley and out upon the glacier continually An avalanche of this kind buried eight or ten people, all but two of whom, however, were dug out alive Another slide buried ten horses and mules, several dogs, and a number of caches. The travelers on the glacier highway soon learned to avoid such

[illegible] danger near the valley walls, especially for [illegible] caches. The accompanying map shows the [illegible] over the glacier in 1898 and how it avoids the [illegible] walls except when forced over to them by the [illegible] near the center of the glacier. The pre[illegible] of avalanches in the daytime, the softness of the trail, and the danger of snow blindness soon [illegible] these men to work and travel at night, there



THE VALDES GLACIER, SHOWING THE TRAIL BY WHICH THE PROSPECTORS TRAVELED IN 1898, AND THE TOWN OF VALDES

being ample light for this purpose between 10 P. M. and morning in this northerly latitude.

A FRUITLESS MASTERY OF A GLACIER BARRIER

Despite all these difficulties the hardy prospectors mastered the glacier barrier on the coast range of Chugach Mountains. By the first of May 2,000 gold seekers had traversed the highway of ice and 1,500 more were on the way across. Many took horses, mules and burros over successfully, two army detachments crossing with 14 and 23 pack animals respectively.

The trip down the shorter Klutena Glacier from the Valdes Glacier summit was easy and rapid, a man being able to draw as much as five or six hundred pounds in a sled. Beyond this there were rapids to be shot, there was a long lake to be crossed, and for this many of the adventurers were unprepared. But, worse of all, there was little or no gold at hand, but there was a long, hard, largely unexplored 250 miles of road over the second mountain range, the Alaska Range, to the Yukon Valley. It was upstream toiling, not downstream floating as in the case of the route from the lakes beyond White Pass to the Eldorado.

The mastery of the glacier barrier had been fruitless. The exodus began early in the summer and prospectors streamed across the Valdes Glacier highway to take ship for home, if they had money, or to stow away or work passage, if penniless, as a great majority were. A few stayed in the Copper River valley and founded the town of Copper Center, some going out during the winter and not a few losing their lives on the glacier. Of those remaining many died during the epidemic of scurvy that scourged Copper Center and Valdes. A very few went on and found fortune the following year.

A few prospectors went across the Valdes Glacier highway early in the spring of 1899, but during the summer and since then the military trail, now a wagon road built by the army over a lower non-glacial pass, has been the highway of entry to the Copper River valley. A telegraph line goes this way now to Eagle and Fairbanks on the Yukon and Tanana. The glacier barrier at Valdez, mastered by thousands of poor, inadequately equipped prospectors who toiled prodigiously and profited nothing, is still a barrier. It can be traversed, but the trail to the east is easier. Men go short distances upon its surface to prospect, one party being seen by the writer in 1904. In 1909 we found a sledge that had been abandoned by another short distance prospecting party. Though temporarily a crowded highway, the Valdez Glacier is no longer traversed, though tourists now go to its front in an automobile.

The Making of Mountains

Even a casual observer as he proceeds along a country road will sometimes notice curiously bent and twisted rocks, some of which strikingly resemble layers of crumpled cloth. The evidence that the forms of these rocks furnish of the action of some tremendous pressure in long past times, which was able to bend and fold the layers of the earth's crust, is of a kind to appeal to the eye and mind of all.

The geologist sees in the mountains themselves far greater proofs of the might of those forces of disturbance that have broken and corrugated the rocky shell of the globe.

The effectiveness of the slow contraction which the earth has undergone as its interior has gradually cooled off in upheaving and deforming its surface has been beautifully illustrated by the experiments of a French geologist.

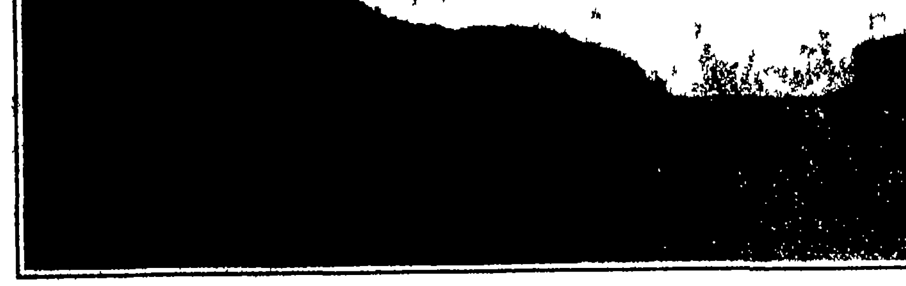
He employed a distended ball of caoutchouc made to imitate the form of the earth, slightly flattened at the poles, and covered it with a layer of beeswax. Then the ball was allowed to contract a little. Immediately the beeswax surface was thrown into folds and fractured and upheaved in some places and depressed in others, the effect being to produce a striking resemblance to the surface of the earth with its mountains and valleys and vast beds of broken and tilted rocks.

So in a few minutes by this ingenious experiment a geological history of the earth in miniature can be enacted, and while watching it with the aid of a little imagination we may behold some of those mighty processes which, acting through millions of years, have gradually brought our planet into the condition in which we see it to-day.

Wireless on Aeroplane

Experiments with wireless telegraphy from aeroplanes are being carried out in France, and one of the first to be successful was made at the Buc aeronautic grounds on an aeroplane piloted by Maurice Farman, using wireless apparatus of the Ancel type. In the first experiments there was used a 4-inch spark coil supplied by four storage battery cells. One pole of the spark gap was connected to the steel brace wires and all the metallic mass of the aeroplane, and the second pole to an aerial wire which was well insulated. This aerial was composed of two 0.04-inch copper wires hanging down parallel to each other and 130 feet long, suspended in the rear of the aeroplane. During the flight the wires took an almost horizontal position. The total weight of the wireless outfit is 45 pounds. In the present tests M. Farman did not carry a passenger, but worked the apparatus himself. Signals were received in the aerodrome shed, using an aerial stretch along horizontally for 600 feet length and mounted on 25-foot poles. The aeroplane flew at 8 miles from the shed and the signals were always well received, using a Ferrié electrolytic detector. New experiments are being made so as to increase the range, using an 8-inch spark and a 300-foot aerial. A passenger mounted on board works the apparatus.

Grapevine Diseases.—Treating of grapevine maladies before the French Agricultural Society, M. Frilleux spoke of the great harm done by cryptogamic maladies by the cochylis and eudemis. For these latter salts of arsenic have been used of late by sprinkling. It was desired to know whether the deposits left on the grapes had any bad effect on the wine or again upon the fresh grapes. On these two points the opinion of experimenters seems to be conclusive, and practically all admit that sprinkling with arseniates or even with arseniate of lead, which is the most dangerous, has no bad effect on the wine or the grapes. M. Gervais confirms these statements and found that no harmful ingredients could be detected in the wine. Upon the grapes it was impossible to find any but the merest traces of arseniates. The society is soon to report upon the use of arsenic salts and also nicotine.



THE RAILWAY OVER THE ALLEN GLACIER, THE TERMINUS OF WHICH IS COMPLETELY MANTLED WITH DEBRIS AND COVERED WITH SHRUBS. GLACIER ON LEFT, COPPER RIVER ON RIGHT. ICE WAS BLASTED OUT IN LAYING THE ROADBED AND COULD BE SEEN IN THE CUTS IN 1909 AND 1910

MASTERING THE ALASKAN GLACIER BARRIERS

Fire and Burglar-Proof Safes—II*

Recent Advances in their Construction

By E E Watson

Concluded from Supplement No. 1845, page 295

THE fire proof safe which will protect its contents from destruction and bring them safely through such fires as that following the San Francisco earthquake the Baltimore fire and the Parker Building fire is of very modern origin

No historical evidence exists of the use of safes for protection against fire earlier than about the year 1820 at which time a portable fire-proof safe was constructed in France This safe consisted of an outer and an inner metal box with a space between filled with some form of non conductor No information is obtainable regarding the details of construction or the materials used Previous to this the only form of fire protection afforded consisted in vaults built of masonry which owing to their cost were limited in use

In the year 1826 a fire proof safe was invented by J Delano This safe was made of oaken planks 3 or 4 inches in thickness which were saturated with salt brine to render them to some degree fire proof and were covered on the outside with bands of iron held in place by wrought iron nails This safe afforded only a moderate amount of fire protection Many of them were destroyed in the great fire in New York in 1845 A safe of this type is now in the possession of the Herring Hall Marvin Safe Company at its Hamilton factory

Some time between the years 1829 and 1832 James Connor of New York City constructed an iron box with a filling between the walls composed of plaster of Paris He used this safe in his own office but made no attempt to patent or manufacture it In 1834 William Marr of England patented a safe the peculiar feature of which consisted of sheets of mica pasted on paper the space between the mica sheets being filled with burnt clay and powdered charcoal mixed

In 1838 Chubb of London produced a safe in which a series of iron plates were used with intermediate spaces packed with wood ashes

Coincident with these various other freak safes were patented and placed upon the market but none of them seem to have left any impress of their individuality on the development of the safe industry

The first real safe patented manufactured and put upon the market as a commodity was introduced by Daniel Fitzgerald of New York city in 1834 In this safe the fire-proof composition consisted of plaster of Paris which was first baked and then reduced to a powder after which it was mixed with water and mica to the consistency of paste and was poured between the outer and inner walls This filling was a good fire resistant but its chemical action upon the iron plates composing the walls of the safe was such that it weakened the construction and rendered the safe entirely worthless in a short space of time

Mr Fitzgerald early associated himself with Azor Marvin who founded the Marvin Safe Company and was long considered one of the heads of the safe industry This Fitzgerald safe was known as the Salamander safe to distinguish it from the wood lined chest built by Delano

In 1843 Tann Brothers invented and patented a safe which depended for its fire proofness upon a filling consisting of ground alum mixed with powdered gypsum These elements were thoroughly mixed and melted together after which the mixture was pulverized and converted into a coarse powder and used in this form for the filling of the safe The mixture when subjected to extreme heat would give off water This safe was known as the Marvin Alum and Plaster Patent and was exploited for many years

During this time numerous other dry filled safes were invented and placed upon the market Various kinds of heat resisting elements were used in the filler, but the safes were not a success on account of the fact that in some instances the steel walls of the safe were corroded by the filler and in other instances the heat resisting qualities of the material used was low and many of these safes—in fact the majority of them failed to preserve their contents when subjected to the test of great fires.

The industry was not placed upon a solid and substantial basis until after the modern concrete filling came into use In 1865 when Joseph L Hall of Cincinnati, Ohio the (at that time) president of the Hall's Safe & Lock Company patented what was known as Hall's Matchless Concrete Filler a safe was made that would withstand severe fire tests and would actually improve with age This filler was composed of cements mixed with certain liquids and contained a large proportion of steam producing elements in solid form In addition to its non-combustible and non-conductive qualities it has the other important advantage of materially strengthening the entire structure It also improves with age instead of disintegrating in the manner of all other fillers that had previously been used

The claim is made that when heat is applied to a mixture such as this the liquid element that is contained within it not in a liquid form however but in what has been characterized as water of crystallization is upon the application of this heat converted into steam thereby changing the heat into work and rendering it latent

The most successful dry fillings previously used depended for their heat resisting qualities upon this same principle but were a failure on account of their destructive action on the steel walls of the safes and for the further reason that they did not add any strength to the structure

In the event of a fire a safe is apt to be subjected to a fall sometimes from the upper floor of a building to the basement Its construction must be such that it will withstand this fall without exposing its interior to the destructive action of the flames In the case of a dry filled safe the exterior shell of metal is apt to be punctured and the dry filling sift out leaving some part of the safe entirely unprotected

The concrete filling above mentioned strengthens the entire safe and by the test of great fires has proven that this added strength is one of the greatest points in its favor The concrete filling invented by Joseph L Hall has been improved upon and is now used exclusively by the Herring Hall Marvin Safe Company in the filling of its entire line of fire proof safes

During the development of the industry much thought was expended upon the construction of the framework and jambs of the safe itself A good grade of cast iron is used in the jambs of the door and the body of the safe This is used for the reason that cast iron will withstand greater heat without warping than bars or plates of steel or iron The framework of the outer box is made of angles securely welded at the corners These angles add strength to the jamb casting and prevent its breakage in case of a fall The outer door plate performs the same function for the casting which serves as the jambs of the door Particular attention is directed to this combination of metals

The cast iron which will not warp under great heat but which is apt to break as the result of a fall

The steel angle frames and the door plate which add the necessary strength to the castings so that they will be able to withstand the shock of a fall

The fire proof safe made fifty years ago and filled with the concrete filling was a creditable article considering the advances made in related industries It was not fitted however with an angle-hoop and the outer body of the safe was necessarily much weaker than in the safes made to-day The fit of the doors was less accurate and the workmanship in general as might be expected not approaching to any degree that of to-day

The safe had many defects The castings mentioned above were cut away on the hinge side of the door for the lodgment of the hinges The hinges were made with an interlocking lug or boss that closed in back of the frame The construction was bad on account of the added metal which tended to conduct heat into the interior of the safe and the weakening effect which it had on the frame on account of the metal that had to be cut out in order to provide space for the hinge.

The recent advances in the construction of fire proof safes consist

First in the Matter of Patterns for Door and Frame Castings—These patterns have been revised and reconstructed at large expense with a view to securing a better fit between the door and its frame Foundry practice has improved to such an extent that castings can now be secured with much less variation in size than formerly To keep pace with, and to take advantage of, this advance in the art of making castings, it was necessary to reconstruct the patterns When this was done seven years ago the tenon and groove and the interlocking-jamb features were incorporated in all of them that had not previously been so constructed We are now using molding machines in the making of many of our door and frame castings, which has enabled us to further reduce the limit of variation in the size of the castings themselves and to fit together a door and frame with the smallest possible allowance for variation in size of castings

Gray iron castings can now be made that will withstand a high degree of heat without warping In the production of our castings we use those materials *which have been determined by experiment to be the* best adapted to the production of a casting of uniform size strength and rigidity

The effect of the close-fitting door together with the features of the tenon and groove and interlocking flange upon the relative fire proofness of the safe is great A closely fitted door braces and reinforces the strength of the frame while a loose fitting door adds the weight of its overhang to the frame and weakens it in direct proportion to the looseness of the fit

Second the Framework—The old style band hoop or frame has been superseded by the solid welded angle-frame The front frame supports the jamb casting and provides a fastening for the hinges This angle is a vast improvement over the old style band or bar frame

The manner of welding the corners is of the greatest importance We have found by experiment that the best and strongest results can be obtained only by the hand method of welding After the angles have been mitered at the corners the edges to be joined are hammered out hot by hand, so that they will over lap each other when bent The actual welding operation is then performed by hand and the strength of a corner so produced has been found by test to equal in nearly all cases the strength of a solid section of the angle itself—a result which we have found impossible to arrive at by any other method

The outer section of the safe has been strengthened by reinforcing wherever experience has shown such reinforcement to be necessary At the same time no unnecessary weight has been added In fact, any weight that does not add proportionately to the strength of the whole structure is a serious detriment in case of a fall In the modern safe we provide angles and bars between the front and rear frames The angles are placed at the corners and the bars midway between These are securely tied to the frames of the safe and provide additional means for fastening and supporting the outer steel wall This outer steel wall as well as the inner steel wall is made heavy enough to properly support and retain the fire-proof composition and light enough so as not to add any superfluous weight to the safe

The proper proportioning of the parts relative to each other and to their various functions is a matter that has been given the most careful consideration in the development of the modern fire proof safe

The doors are hung on malleable iron ball bearing hinges These hinges are fastened on the outside The introduction of the interlocking flange in the rear of the door has made it no longer necessary to mortise them into the door and jambs The burglar would gain nothing by knocking them off The ball bearings by their resistance to wear maintain the door in its proper relation to the frame and provide the additional feature of ease of operation The outside hinge as now used makes it unnecessary to cut away part of the strength of the frame as was formerly done while the inside hinge was used

The operation of the bolting mechanism has been simplified by being made more direct. The locks now used on the outer doors are of the combination type They are protected by steel plates to prevent drilling and the arbors or spindles are shouldered to prevent driving in or pulling out.

An additional device is also provided that will automatically hold the bolts in the locked position in case the lock is in any manner rendered inoperative

Those features in their best form are all of comparatively recent origin, and have added much to the value of the protection afforded by the modern safe

The inner steel doors of fire-proof safes have heretofore been guarded by ordinary key locks The same is true of the small cash boxes usually found as a part of the cabinet equipment. In the very near future the Herring Hall-Marvin Safe Company will equip all of its inner doors and cash boxes with changeable key locks, thereby adding greatly to their security by the facility with which keys may be changed by the user.

* *Journal* of the Franklin Institute

A complete line of steel interiors fitted with the most improved modern filing devices will shortly be completed and placed upon the market by this same company This will be a great advance over the type of interiors now in general use.

To the above-mentioned improvements have been added numerous other minor refinements that result from better mechanical methods modern factory organization, and thorough inspection

There has lately been placed upon the market by the Herring Hall Marvin Safe Company a modern safe fitted with a built-in system of electrical protection This safe may be connected to a central station system or may be fitted with a local alarm In appearance it resembles closely the ordinary fire-proof safe and is a marked improvement over the types of electrically protected safes now in use which depend for their security upon a separate electrical cabinet encasing the safe

In this new safe the electrical circuits are built into the safe itself The circuits are so arranged that any attempt to wrongfully gain entrance to the safe by the manipulation of the locks by drilling or by any other method will cause an alarm to ring

The circuit connecting the safe with the alarm is a closed one and is so arranged that it cannot be tampered with without causing an alarm to ring The Herring Hall Marvin Safe Company owns and controls the patents covering this type of construction

The so-called burglar proof safe or vault has been improved and perfected in many ways in the last ten years.

The development of the burglar proof safe depended in a large measure upon the development of the steel industry and to a great extent also upon the development of locks Until such time as really burglar proof locks had been perfected no great advance could be made in the development of the burglar proof safe or vault

The burglar proof safe of to-day must be drill proof It must be fitted with a door that seats so closely into the opening provided for it that no liquid explosives of any kind can be forced between the door and the jamb

Its bolting mechanism must be of sufficient strength to retain the door in its seat and it must be controlled by locks the operation of which will leave no opening through the door for the introduction of explosives

The modern method of arriving at these conditions differs greatly from the attempts that were made years ago Drill proof steel as formerly used consisted either of Franklinite which was cast or poured between two solid metal walls and allowed to harden in place or strips of so-called spring steel laid between two retaining plates of soft steel

The drill proof steel used in the construction of the modern burglar proof safe or vault is what is known as five-ply steel It consists of alternate layers of hard and soft steel rolled and welded together the result being a plate that will when tempered successfully withstand the hardest drill and will yet retain enough tensile strength to resist the crushing and rending effect of modern explosives This steel was not available in the older types of construction It is now in general use

The most recent improvement in burglar proof construction is the round-door safe and the round-door bank vault The increased closeness of fit can be made in a round door between the door and jamb and the possibility of actually grinding the door to its seat makes this type of construction the highest in existence to-day

The amount of protection afforded by the lighter forms of construction that were in use fifteen or twenty years ago is in the light of present day developments very inadequate It is only in recent years that the jambs or the union between the door and the frame have been polished Earlier than this the machining was roughly done and if too much opening was left a free use of putty and paint at least made an appearance of a fit.

All this has been changed and for the past eight or ten years no burglar proof door has been made by a reputable builder that does not show the polished metal on the edge of the door and jambs.

There are two general types of construction in use to-day, one being characterized as laminated construction, consisting usually of alternate layers of open hearth steel and five-ply steel and the other being what is known as insulated constructions This latter contains an outer section of cast steel containing in its construction insulating materials in which are imbedded drill proof rods or bars, and an inner section of laminated construction

The intention in this latter construction is to eliminate the danger of burning by the electric arc by Thermite or the oxy-acetylene flame

There has been much discussion as to the possible use of these agents by the burglar It is a fact however that long before they were considered in this connection the modern builder of bank vaults had made many experiments and had devised ways and means of overcoming practically all the danger from these sources Many of the older types of bank vaults however are not as well protected in this way as are the recent ones

The general tendency was up until recent years to built vaults very light in construction An 8-inch door was considered a very heavy one Now doors are built as thick as 28 inches and one is now in course of construction in the factory of the Herring Hall Marvin Safe Company that will be when completed 38 inches thick from the outer face of the door to the inner face of the bolt frame plate The total thickness over all from the surface of the operating mechanism of the door to the extreme inner surface of the glass door covering the bolt work will be 61 inches

The greatest advances however in recent years in burglar proof construction have been the result of the application of up-to-date mechanical methods in their production

Modern drill proof steel gives absolutely adequate protection against the use of the drill Steels formerly used and incorporated in the construction of bank vaults were not, however drill proof to the extent that this quality exists in the present day steels These older types of vaults therefore are not as thoroughly burglar proof in this sense as are the more modern ones.

When the vault manufacturer succeeded in producing a bank vault that would successfully withstand the use of a drill he found that his vaults were subjected to attack by the use of the wedge in the crack of the door itself The closeness of the fit of the door did not in any way interfere with the successful use of the wedge

A system of interlocking jambs was devised which in a measure would prevent the springing of the frame away from the door and this reinforced by the more recent overlapping flange of these modern doors has eliminated entirely this source of danger No owner of a modern bank vault need fear either the drill or the wedge

The same security exists in reference to lock spindles that are used at the present time Formerly these were carelessly fitted and openings could be found around them for the introduction of liquid explosives Now they are so carefully ground into the doors that it is impossible even with pressure to force around them any known liquid explosive

The same close fit is now also made of the door in its seat. Every modern bank vault entrance is subjected to what is known as the water test and the door must fit so closely into the jambs that it will resist the passage of water between the door and frame

The operating mechanism of the bolt work has been greatly improved Formerly the bolts were operated through a system of levers and bell cranks that were indirect in their action and were frequently the source of great inconvenience to the user The modern bolt work is operated through gears and racks and is so balanced in its action that very little effort is required in locking and unlocking

The hinges are better adapted to the service expected of them In all modern vaults the doors swing on hinges fitted with ball and roller bearings of the very best design workmanship and materials making a door of many tons weight so easy to operate that a child can swing it in and out, yet so perfectly balanced that it will stand at any point These bearings are fitted with means of adjustment to compensate for wear

The pressure mechanism for seating the door into the jambs has been improved in design and construction

The inner surfaces of the front jambs on all of the best examples of the modern doors are brought to a uniform plane to provide a perfect seat for the locking bolt wedges These wedges have an inclined inner face parallel to the beveled bearing face of the bolts themselves These bearing faces are made as broad and large as possible and the wedges are separately adjusted and fitted under the bolts so that when the door is seated and the locking bolts thrown the holding and retaining power is uniformly distributed throughout the entire system

The modern means employed for binding the locking bolt mechanism to the body of the door consists in tapering or conical bolts running well into the body of the door each bolt separately fit to its seat and all binding the bars through which the locking bolts operate firmly and securely to the door This method of fastening and fitting makes the door with its bolting mechanism an indivisible unit the holding and retaining power equaling the great strength of the solid section of the door itself

In the older types of construction revolving bolts were used The fit of the doors was so imperfect that it was feared that the burglar might pass a saw through the crack of the door and saw off the locking bolts

The structure guarded by the door or entrance which in common practice is called the lining has been strengthened and improved upon in many ways The modern lining is built up of alternate layers of steel plates A combination is made of plates of unusual toughness and high tensile strength with drill proof plates of five-ply welded iron and steel all bound together and protected at the outer and inner corners by massive steel angles The plates of adjoining layers are laid at right angles to each other and the size of the various plates are calculated so as to break the joints The surfaces of all plates are rolled to perfect planes and the edges of plates and angles are ground to a liquid proof fit The angles at the corners are welded into three-way members that effectually bind the vertical and the top and bottom faces of the lining together

The steel plates used in the construction of the modern vault will resist the penetration of the best drills The high tensile plates will successfully resist all explosives and the ground joints prevent the introduction of liquids

Steels of the quality in use to-day were not obtainable in the earlier years of the industry Machinery and machining methods were crude and factory organization as it exists to-day with its team work and all of its multitudinous aids to rapid and perfect production was undreamed of

All the foregoing that relates to improvements in bank vaults applies with equal force to burglar proof safes The same high grade materials are used and the same careful methods applied in the construction of even the smallest burglar proof chest

Burglar proof safes are now made both of the laminated and also of the later solid manganese steel variety that are absolutely impervious to any known method of attack

Coincident with the modern development of the safe and bank vault industry was that of the profession of the bank vault engineer The industry owes much of its progress to the work done by the pioneers of this profession William H Hollar John M Mossman George L Daman E A Strauss Frederick W Holmes Benjamin F Tripp and George I Remington

The days when might was right have given place to the later days when right is mighty The safe industry stands ready to protect your valuables not only against fire and the burglar but against organized mob violence as well

The Cultivation of Cotton in Egypt

DURING the last few years there has been carried out important hydraulic work in Egypt in order to provide a remedy for the great dryness of the climate and to give a great fertility to the soil by irrigation In this way the level of the Nile is now raised considerably and irrigation canals could be run at greater heights than before However this influenced the height of the underground water and in Lower Egypt this now comes very near the surface of the ground At the same time there was observed a lessening in the yield of cotton In the Delta this is especially remarked, and the crop for 1909 was almost a failure Accordingly, the State administration took measures to find out the cause of the trouble. As the only change appeared to be due to the carrying out of the hydraulic work it was thought that the rise in the level of the watersoaked part of the soil was the direct cause of the falling off of the cotton production and to verify this the commission made a series of tests by growing cotton plants under conditions which were the same as usual except that artificial means were provided for keeping certain soils at ranges of 2 to 10 feet depth for the watersoaked layer For each portion the depth was kept constant The results of the tests clearly showed the great influence which the water depth had upon the cotton crop The yield of cotton in each piece of ground is constantly proportional to the depth of the underground water and is better as the watersoaked layer lies farther below the surface. At present the commission is engaged on tests in order to show what are the best conditions for cultivating cotton as well as other Egyptian plants These results will be of value in many other cotton producing countries

In Europe there has been employed a novel method of exploding mines based upon the action of sound waves It is known from laboratory experiments that if a disk which is free to turn about its diameter is placed inside a cylindrical resonator and the fundamental note is sounded the disk will place itself in a plane perpendicular to the cylinder By causing such a turning disk governed by sound waves to complete an electric circuit it would be possible for a warship to explode a mine by giving a certain signal on a siren tuned to the same note as that of the resonator

The Progressive Disclosure of the Entire Atmosphere of the Sun*

By Prof H Deslandres of the Meudon Observatory

The sun to which this paper is devoted is a magnificent subject of study All men feel more or less clearly that terrestrial destinies are closely bound up with those of the sun and that it is necessary to investigate its particular nature its total radiation its variations and in a word its exact and complete effect upon our globe Our dependence upon the sun is absolute and recently this has been summed up in a very simple manner by a French politician now minister of finance To him is due especial credit for the Meudon Observatory which I direct and for the solar researches there pursued At first he refused to consider the matter pleading in excuse the continued increase of the public expenses Then as I became more urgent he exclaimed You are right the sun is *notre maître* the master of us all It is impossible that we should not do something It is thus that the Meudon Observatory has been able to add to its ordinary budget a supplementary sum not large to be sure but coming at an opportune moment and rendering great assistance in the researches which I am now able to present

The modern study of the sun requires a costly equipment complicated apparatus and an observer especially fitted for physical as well as astronomical observations Now the sun shines for all the world and ripens all the crops *à priori* it seems natural that all the men of this planet should co-operate in solar research In accordance with this idea I proposed some years ago to the Astronomical Society of France a very small special and general tax for the sun If each Frenchman said I would give one sou one single sou for the sun the sum total would be large It would be sufficient to guarantee the maintenance of a continuous record of the sun and its variations—a record not yet realized—and therefore a more profound knowledge of this star But now taxes are ever being added on to us and this one although very light and perfectly legitimate would probably be repudiated Moreover it may be said that the individuals of civilized nations especially those who live in towns concern themselves very little with the sun They have less regard for it than the primitive man and the savage who have neither watch nor almanac The realization of this plan is reserved for the future city and for a social state more perfect than ours

Recourse to the government to the people as a whole is a French custom It would be better as in England to appeal to a private initiative to the initiative of enlightened and generous men It is thus that the Royal Institute was founded an institution which has witnessed the development of so many beautiful discoveries and the rise of so many illustrious savants This fine example ought to be cited to all and we may say that it has been largely followed in America where the greatest of observatories and especially those devoted to the sun have been founded by private individuals

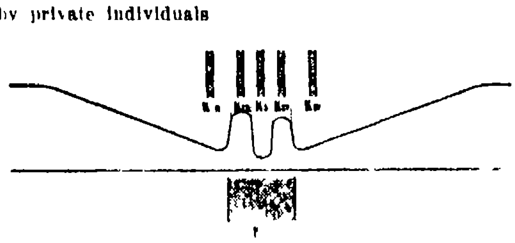


Fig 1—Curve of the Intensity of the Solar Spectrum in the Region of the Broad Band K The Shaded Areas Represent the Different Positions of the Slit of the Spectroheliograph

In fact in the last fifty years thanks to the help of governments and of men of wealth the study of the sun has made considerable progress Astronomers have devoted to it a serious and permanent organization and have even extended it to the entire atmosphere of the star a region hitherto inaccessible

The principal discovery which has been made in regard to the sun is the periodic variation of its black spots a variation which is manifested also by the brilliant faculæ of the sun's surface and by the entire atmosphere which extends out to a great distance The sun as a whole has one great general oscillation and what is even more remarkable this oscillation extends to the earth at least to its magnetic elements

The extension of this solar phenomenon to the earth is of great importance It implies almost necessarily a hitherto unknown special action exercised by the sun upon our globe This is the first cause of the great favor in which solar research is now held Since the discovery by Sabine and Lamont of the connection between terrestrial magnetic variations and

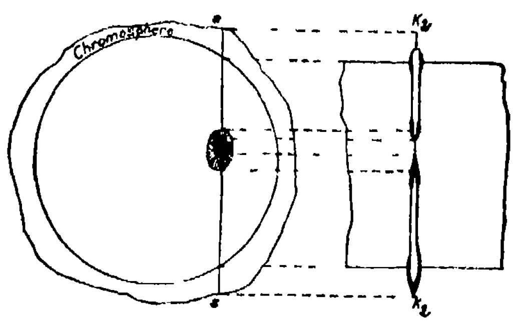


Fig 2—(Diagrammatic) 85 Section Through the Sun in the Plane of the Spectroheliograph Slit The Chromosphere and Spot are Greatly Magnified K Brilliant Line Attributed to Calcium Vapors and Appearing at the Center of the Dark Band K of the Normal Spectrum This Line is Single and Sharp Over the Spots and in the Upper Parts of the Chromosphere and is Double at Other Points Being Divided in Two by the Central Dark Line K₃

solar phenomena English science has paid great attention to sun spots and England was the first to organize systematic photographic observations of the sun spots and magnetic elements at several different points on the earth and to concentrate all of these observations at one observatory which has discussed them with great precision The labors of Ellis and of Maunder in this field are well known and it is well also to recall the works of Lockyer and of S[illegible] who have recently recognized in the variations [illegible] spots periods both larger and shorter than the [illegible]cipal eleven year period

The action exercised by the sun upon the ea[rth is] generally attributed to the spots but it may ha[ve its] origin in the solar atmosphere which has the [same] period of variation hence the necessity of stu[dying] and investigating this atmosphere with care

Now for almost twenty years I have devoted m[yself] to the investigation of the entire atmosphere of [the] sun and I shall present to you herewith the most [re]cent results in connection with the higher layers [of] this atmosphere hitherto unexplored

ATMOSPHERE OBSERVED DURING ECLIPSES AT THE EDGE [OF] THE SUN

The atmosphere of the sun revealed itself to m[en] for the first time during total eclipses at the ed[ge] of the sun's disk It forms at that time a luminou[s] ring bounded on the outer side by the black sky an[d] surrounding the disk of the moon equally black It comprises two distinct parts starting from the moon or the edge of the sun the *chromosphere* thin and brilliant of a rose color from which arise the *prominences* likewise rose colored and then the *corona* much paler but of great extent In what follows the attention will be confined to the chromosphere and prominences In ordinary times the luminous ring seen during eclipses is concealed by the more intense illumination of our sky The screen which hides it is luminous In order to remove this screen the English astronomer Sir Norman Lockyer in 1866 conceived the idea of making use of the spectrum, adopting the quite probable assumption that the solar atmosphere was gaseous That was the idea of a genius who has since made his mark

The eclipse of 1868 showed in fact that the red prominences are composed chiefly of incandescent hydrogen which emits the radiations already recog

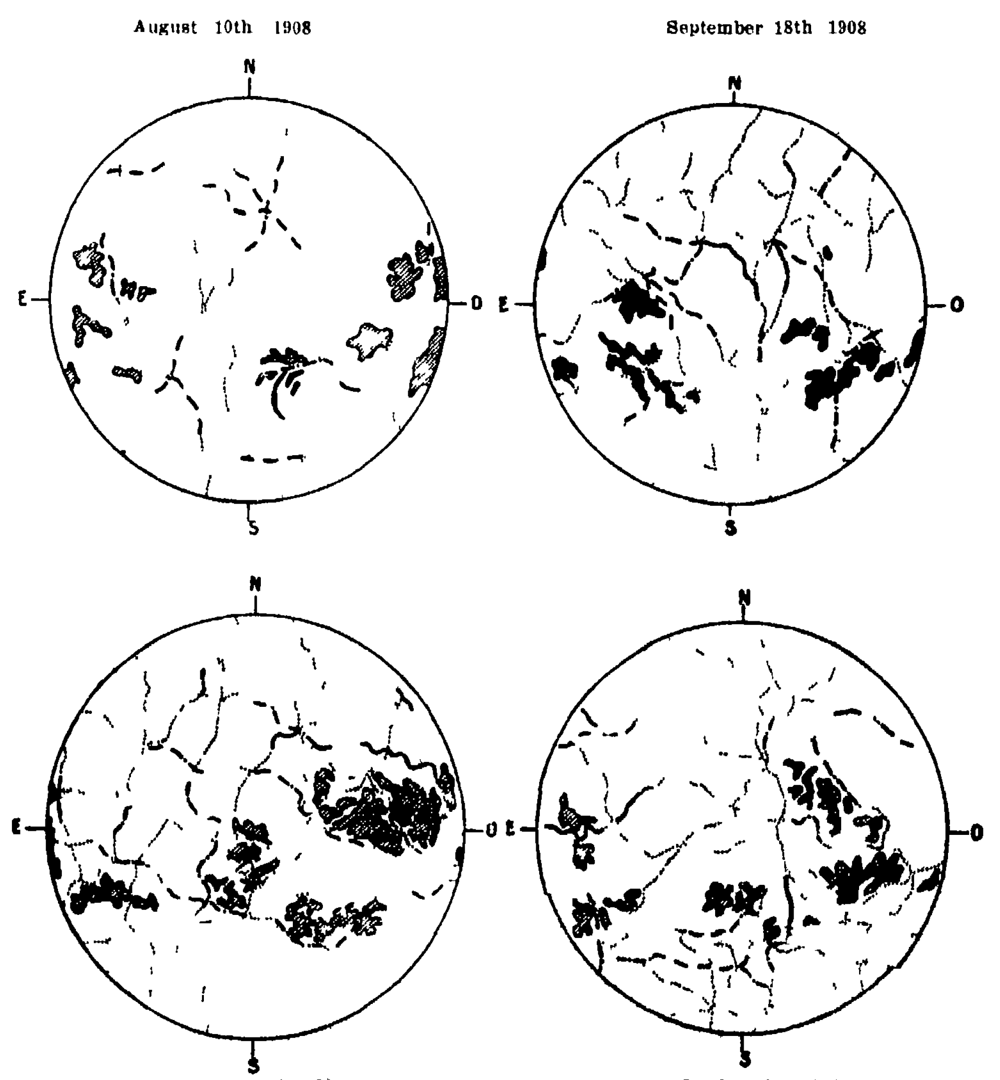


Fig 3—Net Work of Line Markings Observed in the Upper Layer of the Solar Atmosphere The Full Black Lines Correspond to the Sharp Continuous Markings, Known as *Filaments* The Broken Lines Represent Similar but Less Sharp Markings, and the Dotted Lines Correspond to Still Fainter, and Partly Discontinuous Markings. The Shaded Areas Show the Location of the Largest Bright Faculæ

* Discourse delivered at the Royal Institution of Great Britain June 10th 1910 Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Nature* with illustrations from the Annals of the Paris Observatory

in the laboratory under the influence of the electric spark, and in particular an intense red ray $H\alpha$. After the eclipse, Janssen, in India, and Lockyer, in England with the spectroscope and the red hydrogen ray, again found the prominences and the chromosphere seen during the eclipse. This result excited a legitimate enthusiasm for the method so simple yet so fruitful has been used for the past forty years in the daily study of the chromosphere and of the positions and forms of the prominences This study is even more fascinating than that of the spots for the prominences have the most varied forms and exhibit the most rapid changes They appear in all latitudes and also follow the eleven year period of the spots the duration of the maximum being it is true somewhat longer

The spectral study of the edge of the sun carried out in ordinary times or better during eclipses has also revealed the chemical composition of the chromosphere and the height of each vapor determined by the lengths of the corresponding lines in the spectrum

In a general way the vapors of elements of small atomic weight and of the light gases rise to the greatest height Such is the case with hydrogen and helium The spectral line of these two gases which rises to the greatest height is the red $H\alpha$ ray of hydrogen The other hydrogen lines diminish both in length and intensity from the red to the ultra violet

But the highest of all are the brilliant violet H and K lines which are emitted by the compounds of calcium As the atomic weight and the density of calcium vapor are both relatively high this would appear strange, but it is easily explained according to Lockyer by a dissociation of calcium in the sun and in the electric spark of our laboratories The H and K lines (in all respects exceptional) are very brilliant at the edge of the sun and thus render easy the photography of prominences with ordinary plates

On the other hand, the heavy vapors which are by far the more numerous, rise only to a small height in the atmosphere, and are easily visible only during eclipses They form the relatively brilliant lower layer of the chromosphere called the *reversing layer*.

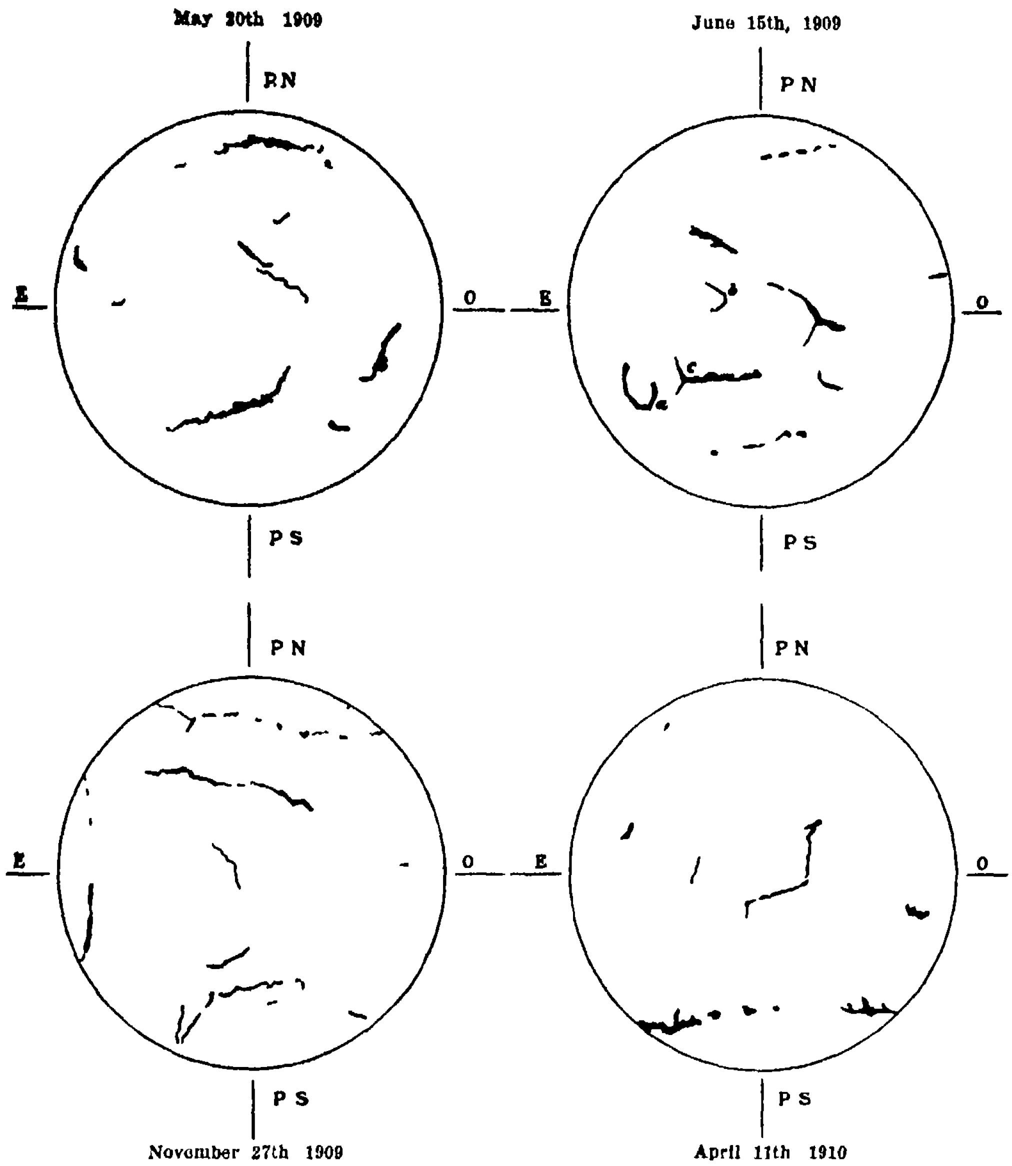


Fig 4—Image of the Highest Layer of the Solar Atmosphere Showing the Characteristic Black Filaments and Especially the Polar Filaments Taken in the Central Part of the Hydrogen H Line or in the Calcium K These Views Show Only the Filaments Without the Alignments

CHROMOSPHERES PROJECTED UPON THE DISK, MIDDLE LAYER

Such are the principal results of the Lockyer Janssen method They are surely remarkable but in certain respects incomplete They apply only to that part of the chromosphere outside the edge of the sun and only to the light vapors which rise from the edge The part within the edge that is projected upon the disk fully fifty times greater in extent escaped them

Now this gap was filled in from 1892 to 1894 by a perfectly general method which disclosed all the vapors high and low and their successive layers in the entire hemisphere turned toward the earth

At the edge of the sun the rays of these vapors stand out bright against the continuous spectrum of our sky but upon the disk these lines appear as dark bands as is well known and the continuous spectrum which serves as a background is the spectrum of the sun itself which is much more intense *A priori* the difficulty appears very great

The calcium lines H and K however form an exception to this rule and this fact was announced simultaneously in February 1892 by Hale and Deslandres These lines are very broad indeed the broadest in the solar spectrum but at points on the surface where there are faculæ they are reversed that is to say they show in their centers a double bright line which in fact appears double not only in the dark band but also in the bright line of the prominences outside the edge of the sun (See Fig 1 which shows the ray K and its components K_{1}, K_{2}, K_{3}, K, K)

The result has been obtained by Hale with a spectroheliograph a new and very complicated apparatus which isolates a radiation by means of a second slit and by the movement of this luminous slit produces a monochromatic image of the sun For my part I used an ordinary simple spectrograph and successive sections of the sun thus paving the way for the use of the spectroheliograph

In the mean time the two observers were disagreed as to one important point Hale located the vapors thus revealed in the faculæ upon the surface I on the contrary located them outside in the atmosphere

Now the ordinary spectrograph which combines all the elements in question furnishes a general solution of the problem It is from this point of view superior to the spectroheliograph

The double line K_2 is brilliant not only upon the faculæ but also upon all other points of the disk where it is to be sure somewhat weaker and more difficult to distinguish Moreover the bright double K is always sharp just inside the edge of the disk and is prolonged outside the edge by a bright double line (See Fig 2 which shows diagrammatically the aspect of the double line K at the edge of the sun and upon a spot)

As the K line outside the edge of the sun represents by definition the chromosphere it follows that a picture in the light of the K line with the spectroheliograph represents the entire chromosphere projected against the disk

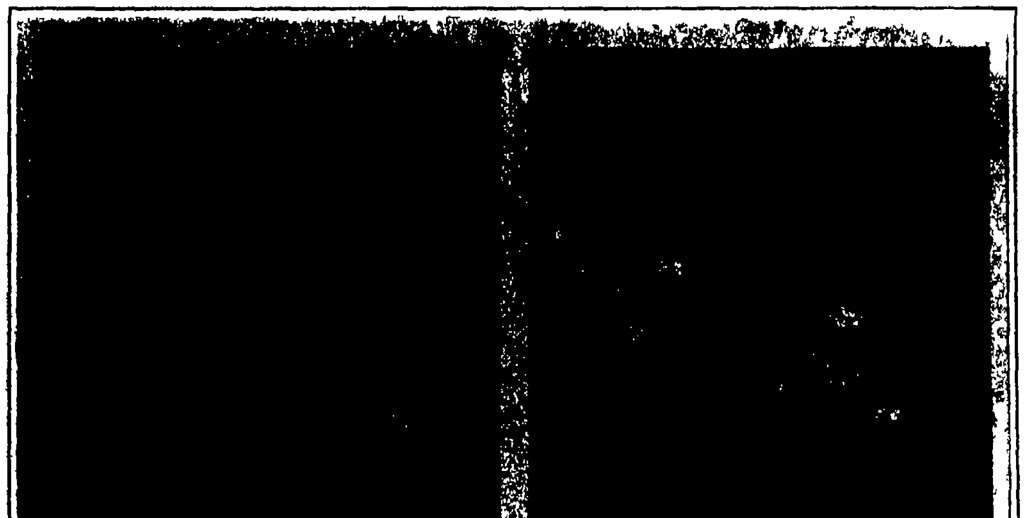
Moreover the calcium pictures made at Paris in 1894 which were the first complete pictures show the bright faculæ larger than upon the ordinary surface photographs and they also show the smaller bright areas now called flocculi which are seen at the poles as well as at the equator I have verified the presence of flocculi at the poles in the years of the sun spot *minimum* and during the whole of the eleven year period

The bright K line remains double outside the edge up to a height of 4 or 5 seconds and as the chromosphere at the edge has a height of 10 seconds we may say that the image in the light of the K line represents the mean chromosphere

To sum up the first spectroheliograph to give results was constructed in America but it was in France that the entire chromosphere of the sun was first recognized

THE SHALLOW CHROMOSPHERE

But we may go still farther In 1893 I announced that the isolation of an ordinary dark line with the spectroheliograph would give an image of the corresponding vapor and in 1894 with a small spectroheliograph of weak dispersion I isolated the low edges of the K ray called K_1 and K and the neighboring dark lines of aluminium iron and carbon The images obtained differed from that of K_2 The



Exposure in the K_3 Line Exposure in the K Line

Fig. 5—Views of the Sun Taken on September 18th, 1908 The View in K, Shows at the Center a Fine Example of a Filament

spots which are at times partly obscured when photographed in the light of K_2 always have their umbræ and penumbræ very sharp when photographed in these other rays The faculæ are bright at the center as at the edge but smaller than in the K_3 images In fact this new image given by the K ray or the rays of aluminium iron carbon etc is intermediate between the image of the surface and that of the mean chromospheric K_2 layer It represents the entire reversing layer which was thus obtained for the first time

A greater dispersion would permit the isolation of the fine lines which are so numerous and especially of the narrow central dark line K_3 between the two components of K_2 This line corresponds to the highest layer of the atmosphere This method is therefore absolutely general It furnishes the images of all the solar vapors and also the images of their successive superposed layers at least when the line is divisible into distinct parts as in the case of the large K ray

Now the number of lines in the solar spectrum amounts to about 20 000 and according to Jewell all the lines present in some degree the same special constitution as this typical calcium line This opens to investigation a new field of vast extent

FURTHER RESEARCHES GREAT SPECTROHELIOGRAPH OF A NEW TYPE

The programme of research marked out in 1894 was therefore most elaborate It has been carried out in part in the ensuing years and the progress has been real if not very rapid

In 1903 Hale and Ellerman at the Yerkes Observatory took up again the study of the dark lines with a spectroheliograph of greater dispersion and since 1906 they have continued this study with still more powerful instruments at Mount Wilson They have obtained magnificent pictures and a large series of new facts With the lines of the reversing layer the results are about the same as those obtained in 1894 but the hydrogen lines and very recently the $H\alpha$ line have shown some new and very curious phenomena which we shall discuss more in detail

Although they have used only moderate dispersion they have isolated a somewhat greater number of lines than were isolated in 1894 but none of the very fine lines And even in the cases in which they have been successful they have isolated the line as a whole They have not separated the line into its distinct parts and obtained images of the successive layers of the vapor Their image is a composite of several distinct images corresponding to different layers

I propose to fill in this gap in the investigation and carry out the programme of 1894 and isolate completely the highest layers which have not yet been revealed Since becoming director of the Meudon Observatory in 1907 I have been able to direct the resources of the Observatory and we have been fortunate in obtaining extensive credit which has rendered it possible to construct a great spectroheliograph as dispersive as the great spectrograph of Rowland and a large special building to contain it

The building covers an area 22 meters by 6 meters Its roof is of stone and earth which assures a constant temperature in the interior It receives the light of the sun from a coelostat at the south constructed from the old transit of Venus apparatus and an old objective of 25 centimeters aperture and four meters focal length These pieces of apparatus which are only mediocre in quality have been used for the sake of economy The spectroheliograph on the other hand is of a new type and possesses several interesting characteristics It is somewhat complicated at least in design for it comprises four spectroheliographs combined with one collimator The first is an instrument with three prisms and two slits, with a length of three meters, giving an image of the sun 85 millimeters in diameter, the second has a grating and two slits, and is of the same length. The third has an entirely different arrangement from the two preceding and the fourth the most powerful of all has three slits and may be used with prisms or gratings It comprises first a spectrograph of seven meters length as in the classic apparatus of Rowland which permits the isolation of very fine lines But

Exposure in the K_3 Line Exposure in the $H\alpha$ Line

Fig 7—Views of the Sun Taken on March 21st 1910 Showing Filament Faculæ and Solar Vortices in the Faculæ

the solar image requires too long an exposure we therefore insert a second spectrograph which diminishes the size of the image to any desired degree and at the same time eliminates the interior diffuse illumination The final image of the sun has a diameter which can be anything whatsoever and thanks to a certain special arrangement of the apparatus the image is complete a result which is not realized in the other spectroheliographs of high dispersion The diameters ordinarily used are six centimeters and our centimeters.

The apparatus with the two spectrographs has a total length of 14 meters and in this arrangement remains immovable It is the first spectroheliograph to be constructed all of whose parts are fixed except the plate The movable parts are the photographic plate and the astronomical objective which are moved at any desired rate by synchronized electric motors and transformers for special speeds The agreement of the motions is assured by electric means independent of distance and this arrangement is presented as a general solution of the spectroheliograph Each of the four spectroheliographs has its especial advantages and the passage from one to the other can be made in a very few minutes The observer thus has at his command the means of carrying out various investigations In a general way the three meter spectroheliograph with two slits gives a larger image richer in detail The great 14 meter apparatus with three slits gives with a longer exposure a much smaller but much purer image and it permits the isolation of the very fine lines

The researches with this apparatus have been carried out with the assistance of a young astronomer of the observatory—M. d'Azambuja, whose name is associated with mine.

DISCOVERY OF THE K_3 HIGHEST LAYER OF CALCIUM

In 1908 we were able to isolate the small central dark band, K_3 of calcium, and thus photographed the highest layer of calcium Fig 1, which shows the K ray and its components will enable one to judge of the progress realized.

Up to that time the spectroheliographs employed isolated only the combination of the two bright K_2 components which inclose the K_3 ray For this a slit wide enough to include 90/100 Angström units of the spectrum was used The resulting image called by us the K_{2} image was a composite of the K_2 and K_3 layers with a predominance of the brighter K_2 by which the highest K_3 layer was rendered inconspicuous Now with the great spectroheliograph with a slit width of only 3/100 Angström units we have been able to isolate easily not only the K_2 ray but also the K_3 and to have the image of each layer perfectly pure and free from all extraneous light The corresponding positions of the slit are indicated in Fig 1 by the shaded bands

The vapor of calcium which at the edge of the sun rises higher than any of the other vapors presents as we have seen three distinct superposed layers If we add the surface we have four layers which it will be interesting to compare

Starting from the surface and going up the faculæ or bright areas increase in extent and in relative brightness The middle-sized flocculi also increase while the small ones disappear or become scarcely visible The result is a characteristic appearance of the K_3 layer which at a glance distinguishes it from the K_2 layer photographed since 1892 (See the two K_2 and K_3 photographs of September 18 1908 Fig 5) I may add that the peculiar network of flocculi called by me in 1894 the *chromospheric réseau* which often covers a considerable area with polygons having their sides and vertices in juxtaposition is in general sharper in the highest layer

On the other hand the black spots which are the chief characteristic of the surface diminish as one goes up and may even disappear

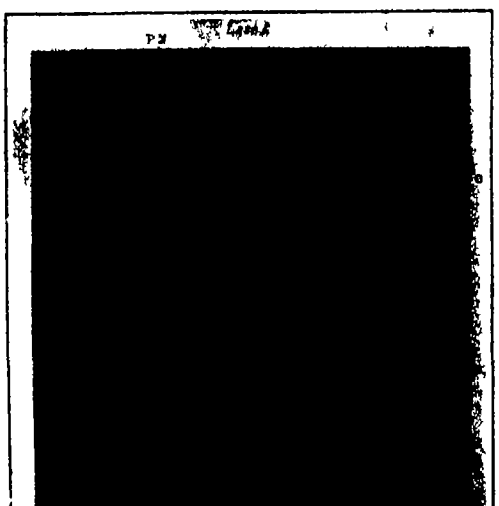
There appear in the highest layer some black lines which are invisible in the lower layers They are often very long and have been called by me filaments In general the filament is continued in both directions out to the edge by other lines less black and less sharp called alignments The combination of the filaments and alignments forms a regular network over the disk of the sun The filaments and alignments are a new phenomenon characteristic of the highest layers

The filament has the same importance as the spot on the surface It persists like the spot through several rotations and like the spot also it is the seat of special disturbances and is accompanied by prominences

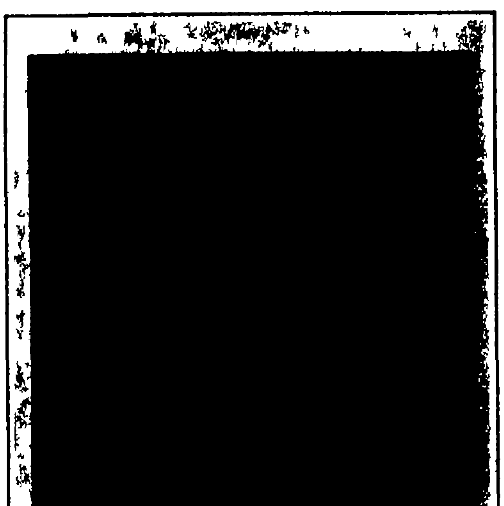
In my first studies I have likened the spots to the barometric depressions or cyclones of our atmosphere, and the filaments to the anti-cyclones. I shall return again to this comparison and develop it more fully

DISCOVERY OF THE HIGHEST LAYER OF HYDROGEN

The following year 1909, d'Azambuja and I with the same apparatus studied the hydrogen lines, and especially the red $H\alpha$ These lines had already been isolated by Hale and Ellerman, who obtained very curious results. In 1908 they discovered that with



Exposure on the Violet Side of the $H\alpha$ Line



Exposure in the Central Part of the $H\alpha$ Line

Fig 6 Views of the Sun Taken September 11th 1909 These Two Views Clearly Show the Difference in the Two Hydrogen Line Images the One Corresponding to the Middle Layer, the Other to the Upper Layer

and H_2 the faculæ are not brighter as in the case of the calcium lines, but on the contrary they are often dark. With the $H\alpha$, isolated in 1908 one generally finds all around the spots a series of fine lines which generally give a distinct impression of a vortex. Most of these $H\alpha$ images are beautiful and very rich in fine detail.

However these American $H\alpha$ photographs were obtained by isolating the spectral band as a whole and I announced in 1908 that they ought to be a composite of two or three images of distinct layers. In fact according to Rowland the $H\alpha$ band is doubly reversed just like the calcium K but much weaker. The width of the $H\alpha$ line including its lower parts is 1 24 Angström units without these parts 0 90 Angstrom units. We ought therefore to expect some slight differences in the images when the different parts of the line are isolated.

Now we have verified completely this fact and indeed contrary to our expectation the differences between the hydrogen images are relatively greater than with the calcium.

The exact results are as follows. If one isolates in $H\alpha$ the lower part near the edge corresponding to the K of calcium for a distance from the center comprised between 0 47 and 0 62 Augström units the result of 1909 will be obtained that is to say the faculæ will be dark with respect to the background.

With the middle of each part between the distances 0 10 and 0 42 Augström units from the center the image is quite different. It presents the chief characteristics of the American photographs of 1908 and especially the groupings of fine lines which Hale has called the solar vortices.

Finally with the center of the band we have a third type of image different from the other two much weaker and less complex an image which corresponds to the highest layer of hydrogen.

Now and this point is important this new image shows the same black filaments as the K_3 layer of calcium. As for the faculæ in this image they are never black but are bright. They are less extensive than with K_3 and correspond to the brightest portions of the bright areas in the K_3 portions which differ from those of the K_1 and K layers. The darkest parts and the brightest parts coincide in position. (See the corresponding K_3 and $H\alpha$ photographs obtained September 11th 1909 March 21st and April 11th 1910 Figs 6 7 8.)

Moreover we have isolated also the different parts of the blue $H\gamma$ line of hydrogen which rises to a much less height in the solar atmosphere than the $H\alpha$ ray and we have obtained images which show the faculæ almost exclusively in black just as in the lower part of the red $H\alpha$ and which therefore correspond to a low level.

Finally we are forced to conclude that the hydrogen as well as the calcium presents three distinct superposed layers which have now for the first time been clearly separated.

Moreover in what precedes I have explained the different parts of the same band and the different images by the ordinary action of emission and absorption in the gas assuming as is natural that the density of the gas and the width of the band diminish as the height in the solar atmosphere increases. But it has been objected that anomalous dispersion can also have some effect and can explain at least in part the peculiarities of the images. Now in my opinion anomalous dispersion certainly ought to enter but to a very slight degree and is neglible in a preliminary investigation. The arguments in support of this assertion would require too much space to develop here. Moreover even if anomalous dispersion has been discovered in the laboratory in the $H\alpha$ line of hydrogen it has not as yet been proved in the case of calcium. Further as the center of the band does not undergo anomalous dispersion the objection does not apply to the highest layers with which we are especially concerning ourselves here.

The black filaments which appear both with the calcium and the hydrogen form a characteristic element of the highest layers. Some of these were suspected by us and some mentioned by Hale in connection with the early complex images of K and $H\alpha$ under the name of long black flocculi and were considered as probably to be associated with the higher layers. In fact under these conditions the most important filaments which correspond to the broad dark bands are generally obtained but the complete investigation of the filaments and their characteristics can be carried out only in connection with the images of the highest layers.

Another important element in these latter layers is the bright faculæ which are found in the same positions as those upon the surface but of different shape.

To sum up then if we consider the four layers formed by the surface and the atmosphere the bright parts are found over the faculæ. The darkest features, however have quite different positions upon the surface and in the highest layer. Below are the spots; above are the filaments which have a black surface area greater than that of the spots. The area of the filaments can easily be measured just as accurately as that of the spots.

RESEARCHES UPON THE MOVEMENTS OF THE ATMOSPHERE SPECTRO-RECORDER OF VELOCITIES

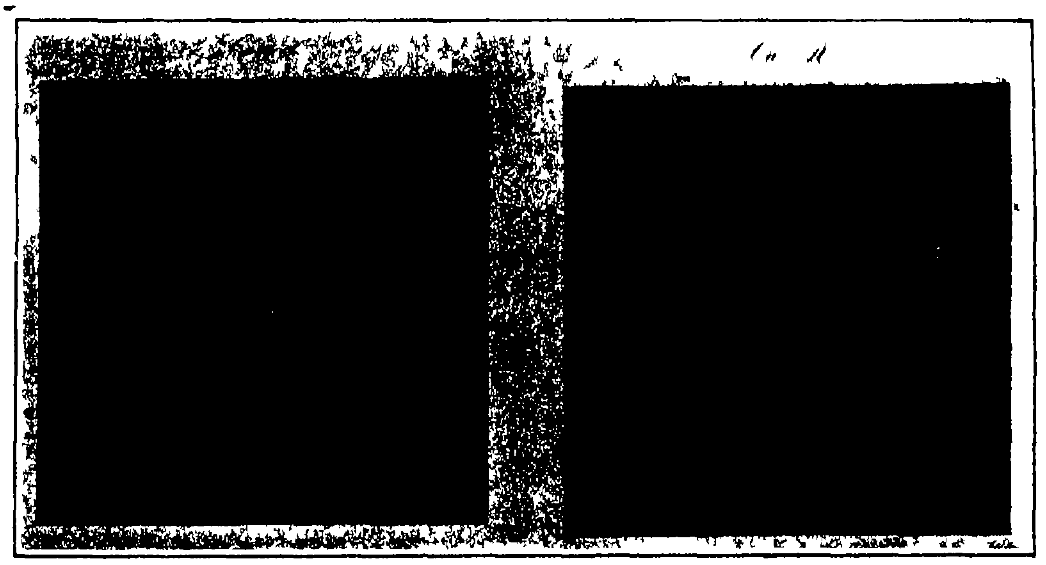
The dark filament attracts especial attention and as has been said above it has an importance at least equal to that of the spots. What is then the origin what is the nature of these long black lines? An exact answer is indeed difficult and in this connection we may recall our lack of precise knowledge of the sun spots which have been studied for three hundred years. However in the case of the filament, the investigation may be easier. The surface in which the spots are located is included between the interior of the sun which is entirely unknown to us and the lower complex layers of the atmosphere. But the highest layer in which the filaments are located is more free and open and may have a structure less complex, and simpler movements.

In Meudon we have recently obtained some most interesting results in regard to the filaments by means of a special apparatus the *only one of its kind* thus far constructed which might be called the spectro recorder of velocities. This instrument which I have used since 1892 was greatly improved in 1907. It reveals as its name implies the radial movements of the solar vapors by juxtaposing small portions of the spectra of successive equidistant sections of the solar disk. This is accomplished by using a wide second slit and an automatic discontinuous movement. This speed meter is a necessary complement of the spectroheliograph and is at least as useful. It reveals in addition to the radial velocities the general forms of the K_3 image of the highest layer the vapor is descending where the image is relatively dark the vapor is ascending. This is perfectly logical for the descending vapor is becoming compressed and heated while the ascending vapor is expanding and cooling.

This phenomenon already detected upon a great many plates is important for it explains the special structure of the atmospheric layers which appear as if divided by convectional currents just like liquids in the laboratory when heated uniformly at the bottom. The bright flocculi often form over a wide area distinctly outlined polygons joined at their vertices and very similar to the polygons which form the vortex cells in liquids so well studied in France by Benard.*

As the vapor descends upon the bright flocculi and rises in the spaces in between each solar polygon thus becomes a vortex cell. As to the other flocculi on the same image they show less marked polygonal shapes or even though more rarely have forms which are wholly irregular.

On the other hand the filaments and alignments probably form the boundary of larger cellular vortices superposed upon those previously formed in the upper layer which have *the spots for their centers*. This conception is in accord with the notion of this layer in the vicinity of spots discovered by the English astronomer Evershed. We can thus easily explain why the spots are points and the filaments lines sometimes very long. The question involved in these researches is therefore already partly answered. The problem will be completely solved I believe by the systematic measurement of radial velocities extending these measurements to the entire disk of the sun a process of great difficulty involving long and tedious labor.



Exposure in the K_3 Line | Exposure in the $H\alpha$ Line

Fig 8.—Views of the Sun Taken on April 11th 1910 Showing Filaments and Polar Curves

of the vapors the details of the entire line and especially the width of the line isolated a width very variable from one point to another on the sun. It reveals points not shown by the spectroheliograph for the latter cannot with a slit of constant width isolate exactly a line of variable width. In a word it registers all the elements which escape the spectroheliograph and permits a sure interpretation of its results.

Upon the plates obtained with the K ray an examination with the naked eye shows at once that the radial movements are in general more noticeable upon *the filaments than upon neighboring points*. Frequently all the K_3 rays of a filament are inclined in the same direction. This indicates a vortex with an axis horizontal as opposed to the vortex with vertical axis which is acknowledged to exist in connection with spots. Moreover this agitation is followed by a relative calm just as in the case of the spots. If we measure with care the displacements and radial velocity of K_3 near the center of the sun we find that the vapor is ascending with a velocity often greater than the equatorial velocity of rotation (say 2 kilometers per second). This fact has been verified upon several filaments. In regions away from spots and filaments the vertical velocities in the highest layer are conspicuous and often of the same order as the equatorial velocity of rotation. The magnitude of this vertical movement is less astonishing when it is noted that the *mass of gas which forms* the atmosphere rests upon an intensely hot surface.

Analogous measurements have been carefully made at the center of the sun upon faculæ and flocculi and the result has been just the reverse. The bright vapor has a descending motion while the relative dark areas near by are ascending. In general at bright points

INVESTIGATION OF POLAR FILAMENTS

I will close by mentioning a new property of filaments recently discovered at Meudon. The observatory already has plates of the upper layer of the atmosphere for more than twenty completed rotations of the sun and from these it is possible to study the distribution of the filaments. They appear in all latitudes but especially around the poles. they are grouped upon a curve more or less circular surrounding the pole but often not concentric with a parallel. This polar curve of filaments is at times sharply defined at both poles but in general it appears only at *one pole and changes from one pole to the other*. This polar curve was particularly strong around the south pole last April. (See the two photographs of April 11th, 1910 Fig. 8 and Fig 4 which represents the filaments on four different days.)

The polar filaments are accompanied by prominences and agree in position with the secondary maxima of prominences which have already been noted near the poles. They may also have some relation to the peculiar form of the solar corona near a sun spot minimum and to the fact often noted that the axis of the corona is inclined to the axis of rotation.

At times the polar curve is accompanied on the side towards the equator by a line of parallel filaments which is joined to the curve by inclined filaments or alignments. We have thus an arrangement analogous to the belts of the planet Jupiter.

Finally the polar zone of filaments where the vapor

* This arrangement of adjoining polygons is at times very distinct over the entire disk of the sun. The K_3 plate of September 18th 1908 shows in the southern hemisphere near the center some of these polygons united at their sides and vertices but a sharper and larger image is necessary in order to see them well.

as we have seen above is ascending may be connected with the zone of spots and faculæ in the vicinity of the equator where the vapor is descending. We are led to infer in the upper region of the atmosphere a great meridianal circulation a great general convectional current, analogous to that which exists upon the earth in each hemisphere between latitude 35 degrees and the pole

The time unfortunately is too short to develop all the consequences of these first observations. The facts presented will suffice to show the great interest in the study of the upper regions of the solar atmosphere and the great necessity of continuing them

The solar atmosphere is the only atmosphere we can study as a whole, and in its successive layers Our recording apparatus will give in a few minutes its general aspect and its principal movements. From this point of view the solar atmosphere is better known to us than the atmosphere of the earth [illegible] we can observe only the lower regions of the [illegible] and those only over a limited area even with the [illegible] of the telegraph.

The network of convectional currents and cur[illegible] filaments discovered in the upper regions of the s[illegible] atmosphere may exist also on the earth, and it is t[illegible] that the study of the sun may teach us to understand better our own atmosphere.

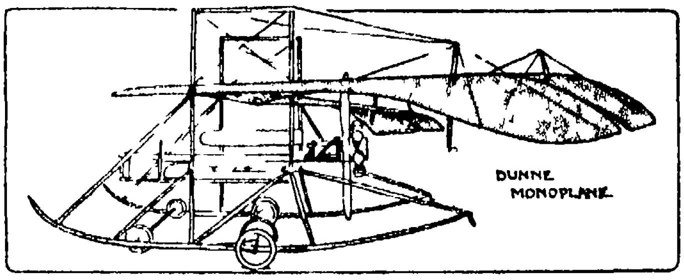
More Aeroplanes at Olympia*

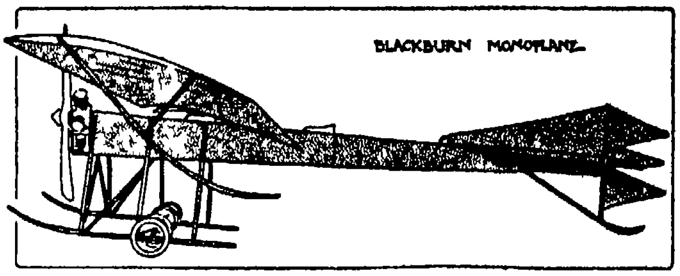
With Special Reference to the Dunne Monoplane

We publish herewith details of the Maurice Farman and Humber biplanes and the Blackburn Piggott Dunne and Nieuport monoplanes

The two biplanes as may be observed afford rather an interesting comparison because they both embody in their construction the characteristic Sommer type forward outrigger in which the skids are carried up for the support of the elevator The Humber machine is also shown with the side pan is designed by A H Bailey for the purposes of stability and control who also exhibited this system in the model section The object of these pan is is to confer the principle of the dihedral angle and to act partially as rudders and partially as screens as was done on the Neale biplane which we recently described and the details of which will be fresh in the minds of our readers The panels, it will be observed are attached at their lower corners by cords to the lower main plane while a single cord attaches the center of the upper edge of the panel to the upper main plane By this means the panels can be skewed or warped into any desired position and the control attachments are such that similar or opposite movements may be made simultaneously in the two panels according to the effect required

Among the monoplanes that which will probably attract the greatest interest among our readers is the Dunne The Dunne monoplane like its prototype biplane is designed to possesses natural stability and is tailless in the ordinary sense of the term In principle however the V plan form of its wings gives it two tails instead of one and the hinged flaps in the trailing extremities of the wings provide it with two elevators instead of one The se flaps are under

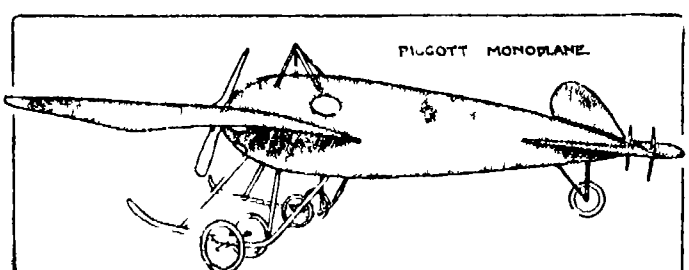


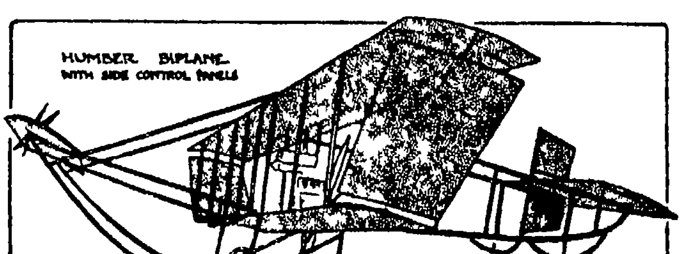


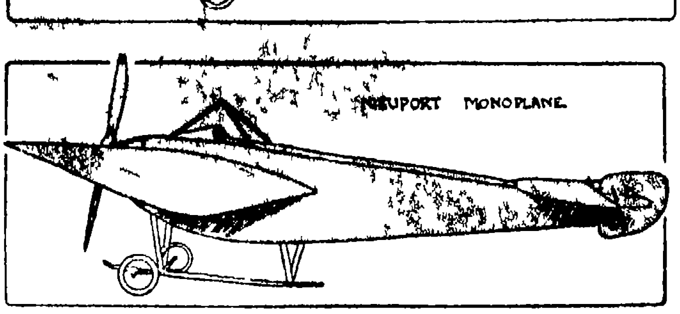
independent control and serve the purpose of steering the machine horizontally and vertically The principle of stability associated with the Dunne monoplane is somewhat complicated and has to do entirely with the special formation of the wings which are generated on the surface of a cone This is not the place in which to go into the details of this method but it will be interesting to learn that the apex of the cone is altogether in a different place being situated on the monoplane a little way behind the trailing extremity of the wing and more or less directly in line with the outside edge This formation of the wing gives a variable angle of incidence from shoulder to tip which in conjunction with the V plan form confers on the machine the principle of the fore and aft dihedral angle which is one of the accepted methods of obtaining natural stability and is a characteristic feature in the design of all successful aeroplanes Owing to the wing extremities being situated in an exposed region and not sheltered behind the middle portion of the plane as is more or less the case with the tail of an ordinary aeroplane Mr Dunne claims that their tail effect is enhanced Also the same argument applies to the efficacy of the dihedral angle because owing to the formation and continuity of the wings it is impossible to define what part constitutes main plane and what part tail That in fact the relative functions of these members are performed by different parts of the wings in accordance with the requirements of the moment

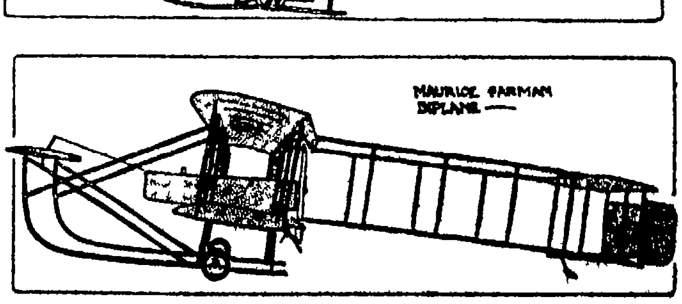
Lateral stability in the Dunne monoplane is somewhat more difficult to explain but that which is the most significant feature in the design is unquestionably the fact that the wing formation provides down turned wing tips as distinct from the upturned wing tips on such monoplanes as the Handley Page and Weiss which are also designed more or less with a view to natural stability It will be noticed of course that it is the leading edge of the Dunne monoplane that is turned down whereas in the Handley Page and Weiss monoplanes it is the trailing edge that is turned up so that the relative positions of the leading and trailing edges in all three machines are identical On the other hand it will be observed that there is a very material and fundamental difference in principle between the two methods for whereas in principle the upturned trailing edge represents the lateral dihedral angle the down turned leading edge represents the gull's wing which is an accepted method of obtaining lateral stability in side gusts. The general action is as follows A side gust ordinarily lifts that side of the machine against which it first strikes, because of the aeroplane action of the planes considered in their attitude toward the gust and the consequent travel of the center of pressure toward the virtual leading edge facing the gust, which involves an actual travel of the center of pressure laterally from the real center of gravity of the machine Thus the machine cants over and the upset is emphasized with the dihedral angle because the upturned wing offers an increasing surface for normal pressure In the gull's wing method the remoter down turned wing tip presents the more effective surface to the gust and tends to counteract the lift due to the travel of the center of pressure on the remainder of the plane It is, in principle little more or less than this idea which was tried by the Wright Brothers in some of their early gliding experiments Like most things of this kind however there is all the difference between the broad principle and the detail of carrying it into effect on a practical machine It is the detail that makes the Dunne monoplane such an original design

Among the other machines illustrated herewith the Piggott monoplane is a remarkable example of the ultra stream line body for in it the engine pilot and passenger are completely inclosed The Nieuport monoplane is an example of the surfaced frame, which may be described as the practical stream line body of the moment and the Blackburn monoplane which is an interesting British built machine is another example in the same category









* Reprinted from *Flight*

The Grade of Iron Ores in Relation to the Question of Available Ore Reserves

In his recent paper on Geology and Economics" Prof J A Kemp discusses the grade (richness) of the several domestic and foreign iron ores in its relation to the question of the world's available ore reserves We quote here the pertinent passages from the source mentioned

"In early days and in remote situations only the richest iron ores could be mined. Magnetites for example in the lump from the Adirondacks afforded over 60 per cent metallic iron Specular hematites from the Lake Superior districts necessarily yielded 65. For some years no one regarded them with respect if they contained less. Red hematites from Alabama at

45 to 50. The minor ores near the furnaces often much lower—but they may be passed over the moment in emphasizing the larger features. Magnetites in the Adirondacks are now concentrated before shipping, and in instances two and one-half to three tons are condensed to one of 65 per cent tenure The crude ore carries 33-35 per cent During the early years of the present decade the general average yield of Lake Superior shipments fell off about one per cent per year—so that now the soft ores so called in contrast with the hard lump specular of earlier days, range somewhat above 50 per cent Alabama ores, once 45 to 50 now are very uniform at 36 to 37 So far as the brown hematites are concerned which in the form of lumps crusts pipes etc are distributed throughout ochres and clays the percentage of available iron in the crude ore is lowest of all We wash from eight to ten tons of crude in order to get one ton of concentrates of say 40-45 per cent in iron and under favorable circumstances may treat much lower raw materials. Soft magnetites in Pennsylvania, which on the richer outcrops gave 45 to 50 per cent, are now dug in very large amounts with a yield of 43 If we take the total production of ore in the United States and the total production of pig iron we find the yield in the large way to be about 50 per cent

In order to gain some idea of the comparative merits of these figures when set alongside the per centages in the ores produced in other lands a few cases may be cited Germany in 1907 produced 27 700 000 tons of ore exported nearly 4 000 000 and imported 8 500 000 Of the local production three-quarters were obtained from Elsass Lothringen and Luxemburg whose percentage in iron ranges between 30 and 40 and is on the whole not very different from Alabama s present percentages of 36-37 Germany s imports of course range much above these figures else the ore could not stand the freight charges from mines in such countries as Sweden Spain and Algiers

Great Britain produced in 1907 approximately 15 000 000 tons, of which about three-quarters were the so-called impure carbonates yielding 30-35 per cent iron One-ninth of the total was red hematite at 50-55 The general average would be somewhat less than that of Alabama Importations of richer ores especially from Spain helped to raise the furnace yield

France in 1908 produced 10 087 000 tons of which 88 per cent was mined in French Lorraine of the same type as the main German supplies The ore ranged from 33 to 40 per cent—again not far from the Clinton ores of Alabama. We are justified therefore in saying that the largest part of the output of the next three producing countries of the world is about the same as the lowest grade of lump ore which can be profitably mined under present conditions in the United States When we estimate comparative reserves we must realize that in the Lake Superior region—our greatest producer—we pay no attention to day to ores which are nevertheless much richer than those of Great Britain and continental Europe

A New Life Saving Buoy

The Miller Luminous Buoy

THE frightful loss of human life caused by collisions and other accidents at sea demonstrates the insufficiency of the apparatus provided for the prevention of death by drowning The lack of proper means of illuminating or even of indicating the scene of accident increases the difficulty of giving aid at night The recent sinking of the fishing steamer Adolf in the Baltic illustrates the consequences of the lack of proper life-saving appliances. Eleven of the crew escaped in a boat and were picked up by a Swedish steamer but the remaining ten men although they were pro-

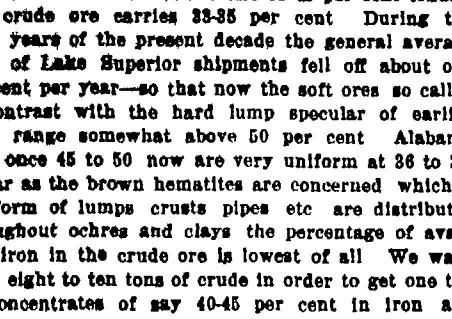


FIG 1 —A NEW LIFE SAVING BUOY HANGING ON THE RAIL OF THE SHIP

vided with cork jackets and floated so near the Swedish vessel that their cries could be heard on board were doomed to slow death by drowning because they could not be found in the darkness

How often the cry Man overboard' is heard and how rarely the poor fellow is rescued At night, especially it is almost impossible for the ship to return exactly to the spot where the accident occurred Life buoys thrown overboard in such cases are seldom picked up although the ship has apparently not moved during the night Even if the victim secures a buoy the boats sent to rescue him may cruise for hours in vain and finally leave him to perish as it is impossible to determine his location especially in a heavy sea

Hence a means of indicating the position of a drowning person at night is required The luminous buoys which are now in use and which usually consist of a cork ring carrying a cartridge filled with a mixture that becomes luminous on contact with water have many defects It is difficult and even dangerous to store and handle the highly inflammable cartridges which often fail at the critical moment In a rough sea the flame cannot be seen by the drowning man to whom the buoy is thrown or by the crew of the rescuing boat If the cartridge is attached directly to the buoy the latter may be burned or injured by corrosive gases and if it is attached by a line of any considerable length the victim may be unable to reach the buoy after finding the cartridge

Capt Miller a retired German naval officer has devised a greatly improved luminous buoy the following description and illustrations of which we reproduce from *Die Umschau* The essential features which assure the efficiency of the device are these The flame is raised nearly three feet above the surface of the water so that it is visible even in a heavy sea. The flame is 12 inches high and produces a light of 700 to 800 candle power which can be seen from a great distance and which burns three hours The burner is attached directly to the buoy

The new life-saving apparatus (Fig 1) consists of a cork ring of 17 inches interior diameter to which the burner is attached by a cardan suspension so that it maintains a vertical position despite the varying inclination of the ring tossed by the waves The lower end of the burner carries a water tight and air tight cartridge filled with calcium phosphide When the buoy is thrown this cartridge is slightly torn with the fingers or automatically by a short chain attached to the cartridge and the ship s rail (Fig 1) A few seconds after the buoy has struck the water the hydrogen phosphide which is generated by the action of the entering water on the calcium phosphide in the carton bursts spontaneously into flame at the top of the burner (Fig 2)

FIG 2—THE BUOY AFLOAT AND LIGHTED

The flame produces dense smoke as well as an intense light so that the new luminous buoy may be used to advantage in the daytime when it is much more easily located than an ordinary buoy The flame is so high above the water that the heat and smoke do not endanger the user of the buoy The efficiency and convenience of the apparatus have been demonstrated by numerous practical experiments

RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR EDWIN GOULD

1 A prize of $15 000 has been offered by Mr Edwin Gould for the most perfect and practicable heavier than-air flying machine designed and demonstrated in this country and equipped with two or more complete power plants (separate motors and propellers) so connected that any power plant may be operated independently or that they may be used together

CONDITIONS OF ENTRY

2 Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown with the mechanism for throwing into or out of gear one or all of the engines and propellers Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize 361 Broadway New York city Each contestant, in formally entering his machine must specify its type (monoplane biplane helicopter etc), give its principal dimensions the number and sizes of its motors and propellers its horse-power fuel-carrying capacity and the nature of its steering and controlling devices

3. Entries must be received at the office of the SCIENTIFIC AMERICAN on or before June 1st, 1911 Contests will take place July 4th, 1911, and following days At least two machines must be entered in the contest or the prize will not be awarded

CONTEST COMMITTEE

4 The committee will consist of a representative of the SCIENTIFIC AMERICAN a representative of the Aero Club of America and the representative of some technical institute This committee shall pass upon the practicability and efficiency of all the machines entered in competition and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional The decision of this committee shall be final

CONDITIONS OF THE TEST

5 Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others and that he is able to couple up all engines and propellers and drive them in unison No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight over a designated course and for a period of at least one hour he must run with one of his power plants disconnected also he must drive his engines during said flight alternately and together Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines the questions of stability ease of control and safety will also be taken into consideration by the judges The machine best fulfilling these conditions shall be awarded the prize

6 All heavier than air machines of any type whatever—aeroplanes helicopters ornithopters etc — shall be entitled to compete for the prize but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7 The flights will be made under reasonable conditions of weather The judges will at their discretion order the flights to begin at any time they may see fit provided they consider the weather conditions sufficiently favorable

8 No entry fee will be charged but the contestant must pay for the transportation of his machine to and from the field of trial

9 The place of holding the trial shall be determined by the Contest Committee and the location of such place of trial shall be announced on or about June 1st 1911

Stone Composition for architectural ornaments—Dissolve 8 parts of glue and 1 part of gum arabic in 12 parts of water and heat the solution to the boiling point During boiling stir in 12 parts of paper pulp Mix the whole with washed chalk Press the paste into well-oiled molds allow it to dry When hard soak it with hot linseed oil

Diesel Marine Engines*

A Resume of Recent Performances

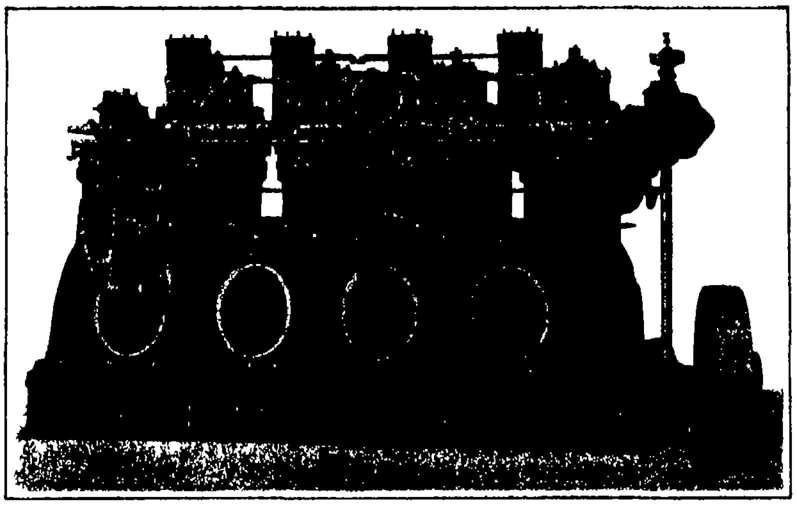
By Herr Th Saeuberlich of Osterholz-Scharmbeck

S N E th days of the old ow press re steam en gines le e has been no time when marine propul sion attra ted more atte tion than to day In the pla e f the highly devel ped steam engine the ef ficiency f whi h it appears impossible further to in reas he D es engine is now making its way for ma i r pos s It is at the present moment the os perfe t ol e gine According to recent experi will like that of the large gas engine follow the ex ample set in steam engine construction

The prejudice against Diesel motors which still exists in shipb ilding circles has to a great extent broken down and recently it has become clear that various shipyards are in the position to build Diesel engines free from faults and reliable in working even with their present equipment

the rough requirements of a ship s auxiliaries

The advantages of the Diesel engine for mari purposes as compared with the steam engine diff according to the type of ship and the size of t equipment but in general the following are amo the most notable The gain in useful space by th reduction of boiler plant and small size of the fue



F G 1 200 HORSE-POWER REVERSING DIESEL ENGINE [illegible] THE [illegible]RFRICHS

th th heat effi ency am nts t from 33 to 35 per cent against 23 per ent wi h gas ngines and 13 per cent with the best superheated steam engines This aris s fro n the direct burning of the f el in the cylinder by whi h means perfect combustion is at tained

In its manufacture the Diesel engine is known to d mand great care in the choi e of m aerials for most of its parts B t in view of the present lay knowledge with regard to metals and the ease with wi h ev ry sort of high lass and suitable ma e ial specially adapted for its p rpose can be obtained and above all in consequen e of the vast s rides made n machine tool man fa t r there is no particular dif fic lty in t rning o t Di s l engines

The large Diesel motor is very similar in its con struction to the steam engine and its development

Hither o the Di s l ngine has be n made almost x l sive y single t ng As a rule the fo r str k y e method has been sed b t recently the two strok ycle has ome into prominence The efforts i z t Dies l engine for quite large ndertak ings and finally for the propulsion of large vessels have g v n a im se o the mployment of doub e a ng eng nes b h on the fo r stroke and two strok yc s In leed s ch progress has already been ma le that ultimate complete success cannot be doubted and leading ship wners having recognize l le gr a val e of internal con b stion engines are alrea ly n y one approaching the shipbui ders wi h their orders

The ns r or is n w co fronted with the task of giving to he Di sel engine h reliability in working a l a a ity fo maneuvering which disting ish the ma e steam ng ne and further in consequence of he o in a le rease in boiler p an to fi l gear s n p e e gh n la dling and maintenance to s it

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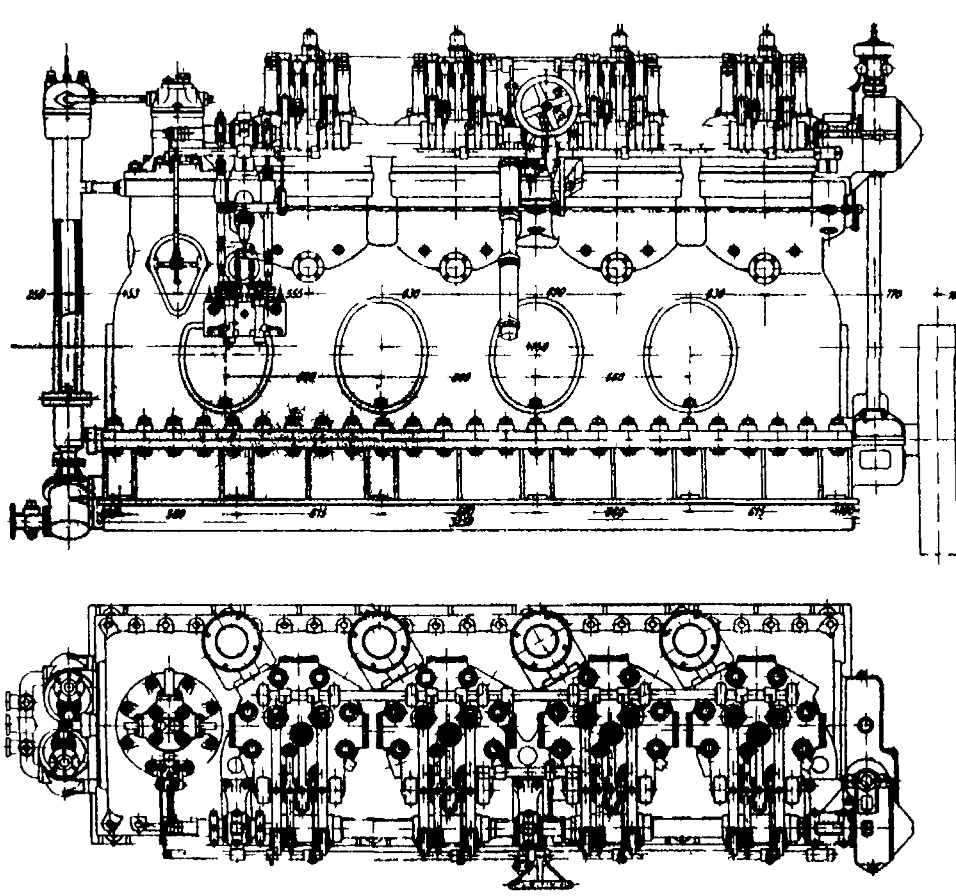


F G 2 ENGINES OF THE FRERICHS

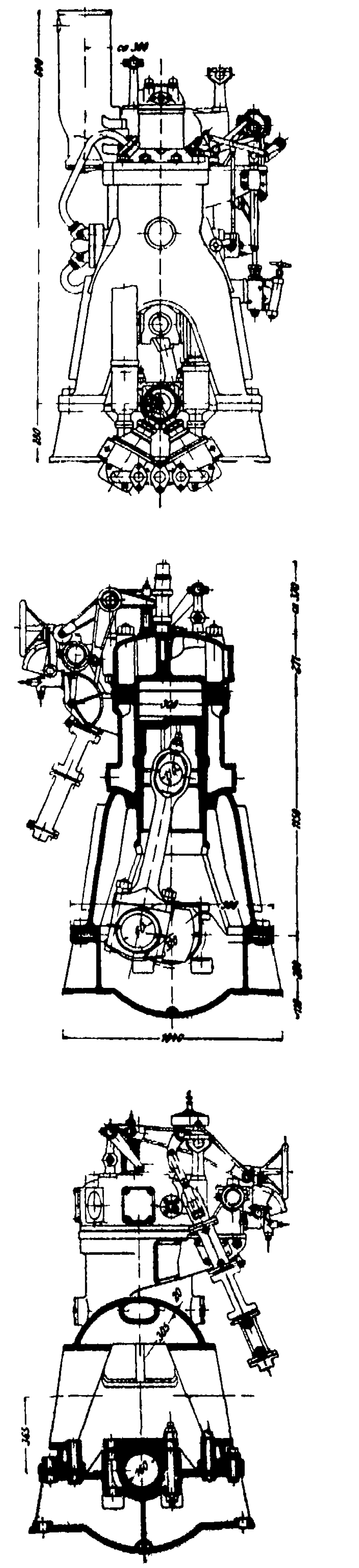


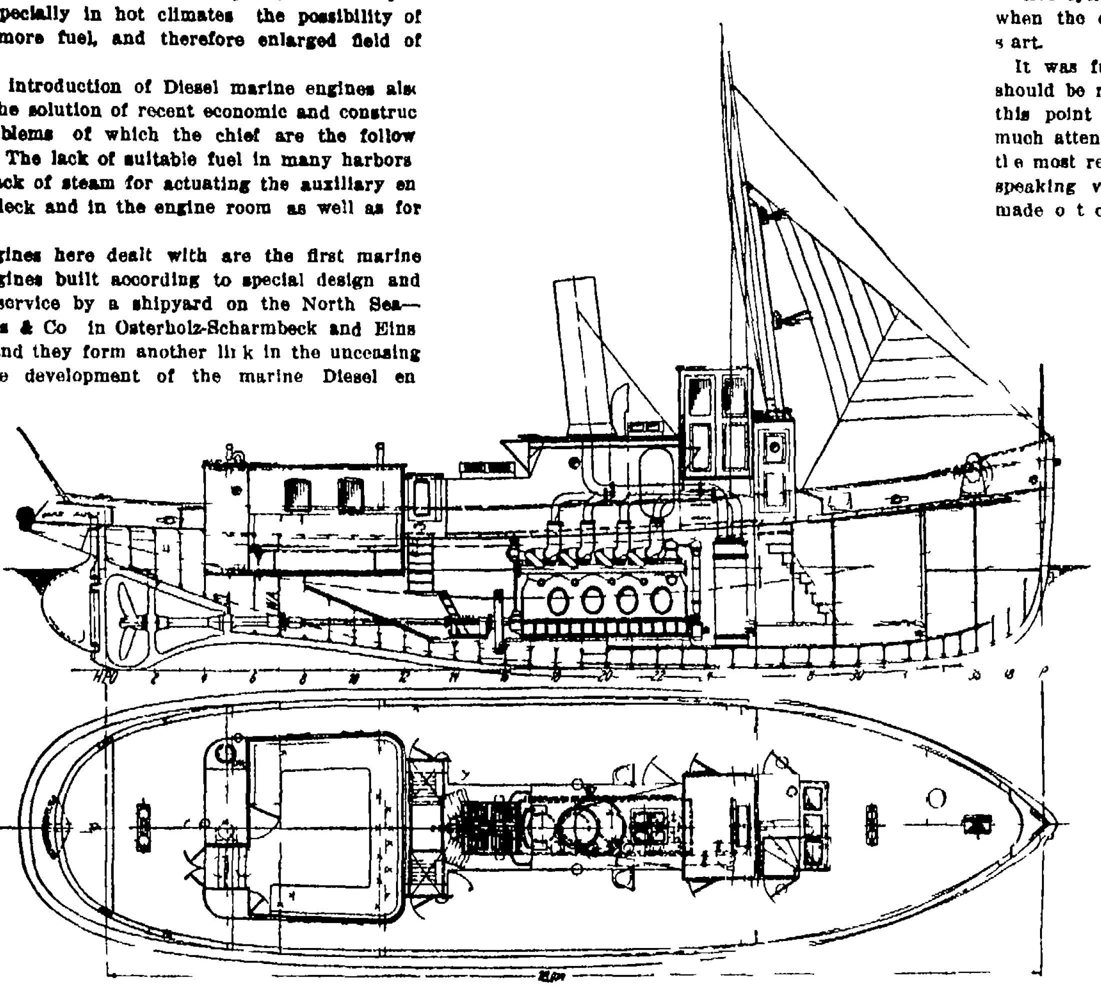
FIG. 3.—END ELEVATION AND SECTIONS

bunkers; increased capacity due to the small weight of the engine plant and the fuel utmost utilization of the otherwise limited useful space taken for fuel bunkers gain in time and economy of wages due to quicker and easier bunkering and also to decrease in coal trimming quicker starting of the engine reduced and easier management personal and space economy by reduction of the number of the stokers reduced cost of fuel cooler engine rooms resulting in the increased mechanical capacity of the personnel especially in hot climates the possibility of carrying more fuel, and therefore enlarged field of action

But the introduction of Diesel marine engines also involves the solution of recent economic and constructional problems of which the chief are the following (1) The lack of suitable fuel in many harbors (2) the lack of steam for actuating the auxiliary engines on deck and in the engine room as well as for heating

The engines here dealt with are the first marine Diesel engines built according to special design and put into service by a shipyard on the North Sea—J. Frerichs & Co in Osterholz-Scharmbeck and Einswarden—and they form another link in the unceasing progressive development of the marine Diesel engine They are (1) the direct reversing four cylinder Diesel engine of a maximum effective 200 horse-power with 360 revolutions per minute fitted to the service boat "Frerichs" built by the above-named firm (2) the 90 effective horse-power two-cylinder marine Diesel engine and reversing gear for driving the herring lugger "Ewersand" which is employed by the Brake Herring Fishing Company in Brake

The Service Boat Frerichs This service boat is a single-screw vessel built according to the rules of the German Lloyd for small coasting traders and has been in use since the spring of 1910 She serves for the special purpose of communication between the shipyard in Einswarden and the opposite bank of the Weser but especially for towing For this purpose she is equipped with a strong towing gear The towing power amounts to about 2 000 kilogrammes measured on the rope. The fuel employed is the so-called gas-oil 1 000 kilogrammes of which are provided in two tanks under the cabin double this quantity could however, have been conveniently carried These 1,000 kilogrammes permit of a voyage of 240 sea miles at 9½ knots, a distance which corresponds to about the voyage from Bremerhaven to Hamburg and back



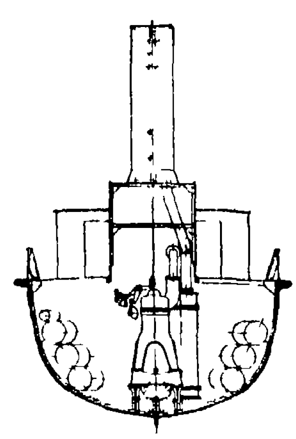


Fig 4—THE SERVICE BOAT "FRERICHS"

The vessel in external appearance is like a steam tug since she has a funnel for carrying off the gases With a length of 18 meters she has a very spacious engine room On deck near the pilot house and other deck erections is a large cabin affording room for twenty people The existence of this roomy accommodation is due to the omission of boiler and coal bunker space The motor Fig 1 is a reversing four-cylinder four cycle engine direct coupled to the propeller shaft at 360 revolutions it develops 200 effective horse power measured on the fly wheel and gives the ship a maximum speed of about 10 knots Its weight is about 10 000 kilogrammes

The reversing gear is actuated by compressed air abundance of which is available which moves the horizontal cam shaft endwise thus bringing a second set of cams into action Starting can be made quickly and safely and can even be effected in one second By a special arrangement of the compressor perfect certainty is guaranteed with regard to the starting of the engine in either direction even in the event of the motor stopping on the dead center The valve gear of the motor is the simplest imaginable All the necessary movements and arrangements are combined in a single mechanism For the entire manipulation including the regulation of the motor for high or slow speed all that is required is a single lever which for convenience is designed as a hand wheel

The cooling water pumps and Lenz pumps are driven by the engine crank shaft by an overhung crank and are—see Fig 3—fixed to the common base plate

The hot exhaust gases are cooled with water on their discharge from the cylinder in a double walled chamber After their union in a collecting pipe they are conducted into a large condenser which acts as the part of a silencer From there the exhaust pipe leads into the funnel where the exhaust gases pass into the air

The Lenz pump provides cooling water for the exhaust The compressed air which is required for maneuvering is generated by the motor itself by means of a two stage compressor which constitutes as it were the fifth cylinder of the motor It is received in six large receivers—Fig 4—which are placed along the side of the engine room and made fast to the ships side where they take up little room Further a smaller air receiver is also arranged on the port side. From it the air for the injection of the fuel into the cylinder and for reversing is taken The six large receivers serve only for starting The air used for starting is during the voyage gradually restored again from the small supply tank In the construction of the motor the utmost simplicity was sought, and it was especially demanded that the number of the cylinders and the movable parts should be limited as far as possible

To start a four cycle motor in any position at least six cylinders are required if the usual method is adopted It was however desired to limit the number to four cylinders and a way was found by making use of the compressor direct coupled to the motor This compressor is of special design and is provided with a gear which makes it possible to use it as a motive cylinder driven by the air from the receivers when the engine cylinders are not in a position to start.

It was further required that the cost of the plant should be reduced to the lowest possible amount To this point of view the constructor cannot pay too much attention since the cost of Diesel engines until the most recent times has always been comparatively speaking very high The base plate of the motor is made out of cast iron and in one piece It is closed [illegible] and the separate crank pits are connected below by channels so that the lubricating oil can flow to one end The main bearings Fig [illegible]—are recognizable as on the whole similar to the usual type in ship construction the lower brass is rounded and therefore easy to remove the upper on the contrary is squared A plate of Siemens Martin steel takes the place of the bearing cap

The general form of the standards will be gathered from Fig 5 It will be seen that great care has been taken to avoid sharp corners and sudden changes of form The whole piece is a single iron casting The lower part is semi-cylindrical above and the ends of

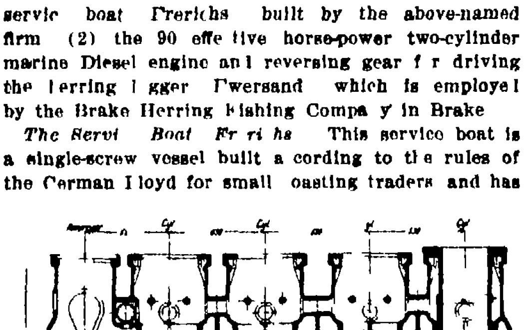


Fig 5—CAST IRON STANDARDS

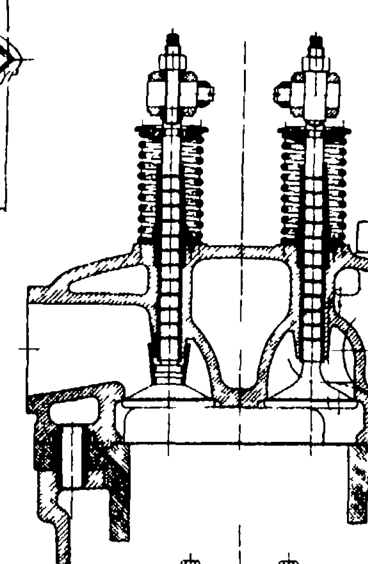


Fig [illegible]—CYLINDER COVER

it are domed The two walls are splayed outward to the base and pierced by large elliptical openings The cylinder liners fit the casting as shown and the water jacket is kept tight by a calked leaden ring All the jackets are in communication with each other by the passages shown in the drawing Round cleaning holes are provided in each jacket Between the compressor and the adjacent cylinder a square box is formed in the casting which constitutes an inter cooler for the compressor The brackets which support the valve shaft are also cast on The thickness of the casting is throughout about 20 millimeters

The cylinder cover is the largest and heaviest casting in the engine and on it are collected all the principal valves—the suction valve the exhaust valve the starting valve and the fuel valve All these parts have to be got into a constricted area little bigger than the piston diameter and yet to avoid unequal thicknesses of metal reasonable spaces must be left between the separate parts This arrangement is also necessary to insure equal cooling and to avoid stresses being set up by unequal heating. Furthermore an exceedingly sound casting is absolutely essential particularly at the joints and valve faces, and at those surfaces subjected to the high internal pressure in the cylinder or connected with the high pressure air supply

To carry out all these requirements however, presented little difficulty As may be seen from the engraving Fig 8 the suction and exhaust bends are separated from the two tubes or passages which take the starting and fuel valves The exhaust bend is entirely surrounded by water and is of such a shape as to give an easy flow to the gases The exhaust and admission valve seat direct on the cover for in no other way was it possible to bring them so close together It may be objected to this arrangement that dismantling is far more difficult than when separate valve cages are employed as it involves the removal of the whole cylinder cover but in an engine of this size no trouble in this direction has been experienced The only real objection is that the part of the valve spindle exposed to the hot gases may wear more rapidly than the remainder which is water cooled, but to reduce this objection the lower part of the spindle is protected by a cone from the direct impact of the hot gases. In the case of larger valves the employment of a liner is, of course, recommended. In order to make the cooling as effective as possible, the walls are made only 12 millimeters thick.

From the foundryman s point of view the casting of the cover presents now no difficulty but before the best mixture was found a considerable number were tried In the tests the fact that only the closest and densest blends should be employed was disregarded, and it was proved that the best results were obtained with the iron in ordinary use for steam engine cylinders All that is required is to use special care during casting and to keep the liquid iron after the mold is full in constant motion by means of a pump, to make sure that the mold is completely filled and the iron homogeneous

(To be continued)

The Two-point System Ignition

Merits of the Scheme Outlined

A talk on ignition and ignition methods given by Roger B Whitman of the Bosch Magneto Company not long since before the Long Island Automobile Club developed the merits claimed for the two point system Mr Whitman dealt with the details of ignition and its method His paper is given almost in its entirety below

The state of perfection of the present day internal combustion engine has not been reached without deep study and investigation in the course of which it has been realized that ignition has vastly more to do with efficiency than was at first believed

The early conception of ignition was the production of a spark some time toward the end of the compression stroke and if this spark was successful in igniting the mixture that was all that was desired The character of the spark the accuracy of its production or the exactness of its timing were points that were disregarded by the designer because he did not understand that these had any bearing on the power output or on the fuel consumption of the engine

The modern designer takes an entirely different view of the subject however and it may be of interest to outline the problem as it is now understood

To appreciate the fine points of ignition as they are understood to-day the engine must be considered in its true light as a heat engine pure and simple

The mixture that is drawn into the cylinder during the inlet stroke represents a certain heat value and the efficiency of the engine depends upon the manner in which this heat is applied to the expansion of the gases Any condition by which some of this heat is lost or by which it is not applied directly to the forcing of the piston outward on the power stroke will reduce engine efficiency

The first step in the securing of efficiency will be to study the points at which losses of heat may occur and to adopt means by which these losses may be prevented

The charge of mixture represents a certain heat value and has a certain maximum pressure To exert the greatest possible proportion of this pressure against the piston each particle of mixture should be made to give up its heat at the instant when the piston is at the end of the compression stroke and ready to move outward on the power stroke

To gain this result it would be necessary to ignite each particle of the mixture at the same instant, and thus to have ignition and combustion occur at top dead center The mixture would thus be compressed into a minimum space before ignition, and the rise in pressure due to combustion would then be most abrupt the piston being driven outward with maximum force

No existing ignition system will permit the ignition of all of the particles of mixture at the same instant The system in use therefore permits ignition of the mixture at one or two points from which the flame is expected to communicate itself to the remaining mixture particles

In a perfect mixture each particle of gasoline vapor will be surrounded by the particles of air necessary for combustion and to ignite the mixture it will be necessary to raise the temperature of these particles to the point at which the chemical change known as combustion will occur

Under usual motor conditions the heat developed by the electric spark is depended upon to raise the temperature of certain of these particles to the point at which they will ignite, and the flame thus started is communicated to the particles of the mixture immediately surrounding it this being propagated throughout the entire charge

To our senses the spread of the flame from the point of ignition is instantaneous but in comparison with the speed at which a gasoline engines operates the time required is very considerable and must be taken into consideration Thus there enters into our calculations the period of time that must elapse between the instant at which ignition occurs and the instant at which the entire charge will be inflamed

We desire to apply to the piston the greatest pressure possible and obviously the greatest possible pressure will be produced at the instant when combustion is complete At this instant therefore the piston should be at the top of its stroke We must not overlook the fact however that some pressure is produced at the instant when ignition occurs and that this pressure will be constantly increasing as combustion spreads If combustion is to be complete when the piston is at its top point it is clear that ignition must occur while the piston is still moving upward on the compression stroke For the last portion of its stroke the pison will therefore be subjected to this pressure which is rising to maximum and by which the piston will tend to be driven backward at the same time the momentum of the fly wheel is urging the piston upward Some of the power of the engine will thus be required to force the piston upward and in this is found one of the most serious of the losses in engine efficiency If the engine is going at a sufficient speed the momentum of the flywheel will force the piston against the pressure in the combustion space to top center but the result of the conflicting pressures will be shown in abnormal wear of the wrist pin crank pin and main bearings

You have all had experience with a back fire when cranking an engine and know that it is the production of maximum pressure in the combustion space before the piston reaches the top of its stroke the result being that the engine starts to run backward This same condition in a lesser degree exist in a running engine under the normal condition of ignition occurring before top center

The charge of mixture represents a certain heat value and can be made to exert a certain definite pressure upon the piston To get the best possible results all of this pressure should be exerted against the piston when the latter is at the top of its stroke If some of the pressure is exerted before the top center is reached less pressure will of course remain to act on the piston during the power stroke This entails a double loss for not only is the rotation of the crank shaft somewhat retarded but the maximum pressure developed at top center is reduced The effect is shown in an increase in the consumption of fuel and in a reduction of the power output

Another loss that results from ignition earlier in the stroke is due to the absorption of heat by the cylinder walls the surfaces being of metal are natural conductors of heat and of course the longer the period during which the flame is in contact with these surfaces the greater will be the heat absorbed and wasted in this manner

The obvious way to reduce loss of power from these causes is to produce ignition as late in the stroke as possible but in this we are limited by the necessity for having combustion complete at top center

The remedy will therefore be to hasten ignition as much as possible or in other words to reduce the time necessary for the propagation of the flame throughout the mixture

One of the most important factors in this is the location of the spark plug which should be so placed that the distances through which the flame must be spread are as short as possible If for instance the plug is located in the inlet valve cap the distance through which the flame must spread will be practically maximum and the operation will require more time than would be necessary if the spark plug were located in the cylinder head Furthermore the plug should be located that its points are actually plunged in the mixture and not set in a cavity or pocket Engines are occasionally seen with valve caps that are solid and possibly an inch thick If a standard plug is screwed into such a cap the spark points will be found some distance up the hole the spark will ignite the mixture which is in the hole and some little time will be required for the flame to spread down to the hole and to be communicated to the mixture

Such a construction will require considerably more advance of the spark than would be necessary if the spark points were in direct contact with the charge

The size of the ignition spark is also a factor that determines the time required for combustion The ideal ignition spark should be a mass of flame with as large a surface as possible for this will result in the ignition of a large number of mixture particles. It should be understood that the spark must come into actual contact with the mixture particles in order to ignite them and if the spark is thin it will be quite possible for it to pass through a throttled mixture without actually coming into contact with any of the particles With a spark that is in the nature of a flame this cannot take place A large spark not only insures ignition but makes combustion more rapid for combustion will certainly be more rapid if for instance a hundred mixture particles are ignited by the spark instead of but one

Following along this line brings us to the proposition that it might be better to ignite the mixture at two widely separated points instead of at but one on the theory that this will reduce the time necessary for the propagation of the flame

If a spark plug is placed in the inlet and a second one in the exhaust valve and sparks are caused to occur at these plugs at the same instant the time required for the spread of the flame throughout the whole charge will be much less than would be necessary were the flame to originate at one side and be required to spread across the entire width of the combustion space

This has been theoretically admitted for a long time but the difficulty in its practical application lay in the securing of apparatus that would permit the production of two sparks at absolutely the same instant

Ignition apparatus of this character has now been perfected however with results that are satisfactory from every point of view It may be said at the beginning that it is essential to locate the spark plugs properly If the two are set side by side in the inlet valve cap, for instance, there will be no gain through the use of two spark ignition over one spark. To secure proper results from this system it is necessary to separate the plugs and to locate them so that the flame will have an approximately equal distance to spread in all directions from each.

A series of comparative tests was recently made

…gine arranged for operation either with one … or with two The engine was a four-cylinder …-inch bore by 4¾-inch stroke and was con…ed to an electric dynamometer that made it pos…e to gage the power output very accurately

With single spark ignition the maximum output …6 horse-power was reached with an ignition ad…ce of 45 degrees, with two-spark ignition the …e output of 24 horse-power was obtained with …advance of but 18 degrees and a maximum output …8 horse-power was obtained with an advance of … 32 degrees. In other words the maximum power output possible with single spark ignition was equaled by two-spark ignition at considerably less than one-half the advance while with two-spark ignition it was possible to increase the maximum power output by 16 per cent

At first sight it seems somewhat extraordinary to claim that the power output of an engine will be increased 16 or more per cent by producing ignition at two points in the cylinder instead of at but one … the line of reasoning that we have followed makes it clear that the gain is due to the preventing of losses that follow early ignition

The two-spark ignition system has been used on racing cars since last fall the Vanderbilt race mark… its first appearance on American roads In that race Dawson s Marmon car was equipped with a Bosch magneto of the two-spark ignition type and no one who saw it run could fail to be impressed with its extreme speed and its extraordinary ability to pick up after a slowdown

All cars entered in races subsequent to the Vanderbilt have been equipped with two-spark ignition and to get down to actual results it may be said that the Marmon and Lozier cars showed an actual increase in speed of from four to five miles an hour on changing from single to two-spark igition (Bosch)

This system unquestionably marks the greatest improvement that has been made in engine operation for a number of years past The magneto itself is of great simplicity for it is identical with the ordinary magneto except that a second distributer is provided In the magneto of the independent type one end of the armature winding is grounded on the armature core and the current after passing through the spark plugs returns to the grounded end through the metal of the engine and magneto In the two spark magneto this end of the winding instead of being grounded on the armature core is carried out through the distributer and grounded on the engine through the second spark plug The circuit therefore consists of the armature winding one distributer one spark plug to engine ground to the metal of the engine and thence to the armature winding by the second spark plug and second distributer

Not the least advantage of this system is its great reliability for one plug may become fouled without interfering in the slightest with the operation of the other It has further been many times demonstrated that oil has far less effect on this system than it has on a single plug system and that overoiling that would put a single spark magneto completely out of business will not interfere in the slightest with the perfection of the operation of two-spark ignition

We have seen the necessity for causing ignition to occur as late as possible in the stroke and it follows that we must use ignition apparatus that will produce the spark at exactly this point and at no other

If the apparatus selected does not produce this result, and if it permits the spark to occur a little earlier on one stroke and a little later on another the result will be an unsteadiness in the operation of the engine a reduction in power output and an increase in gasoline consumption

Any one who has had experience with an automobile knows that the engine will run more steadily and more powerfully on a high tension magneto than it will on a battery and coil system but the reason for this is not always understood It lies largely in the fact that the magneto produces a spark absolutely accurately and without variation while with the coil and battery system the point at which the spark will occur will vary considerably

The battery timer will make contact definitely and at the proper instant but this does not mean that the spark is produced accordingly

Upon the closing of the battery circuit by the timer the battery current is permitted to flow through the primary winding of the coil with the result that the core becomes magnetized The effect of this is to draw the vibrator blade away from its contact and thus to break the battery circuit the consequent collapse of the magnetic field causing the induction of a high tension current in the secondary winding It is this current that furnishes the spark

It is seen that the electric current is required to do certain work between the closing of the circuit by the timer and the production of the spark at the plug and the lack of accuracy in the system lies in the fact that the current does not always consume the same time in performing those functions

This can be demonstrated on apparatus that consists of a shaft that may be driven at variable speed by an electric motor This shaft carries a pointer that travels around the inner side of a graduated ring One end of the shaft carries a battery timer while the other end drives a high tension magneto the magneto armature and the timer revolving at the same speed

The circuit is so arranged that the spark produced by the magneto or by the coil may be caused to pass between the moving pointer and the graduated ring

Turning the apparatus slowly by hand with the magneto thrown into the circuit will show that the spark is produced at the zero point of the graduation By throwing in the electric motor the speed may be increased to anything up to about 1 500 revolutions a minute and it will be seen that the magneto spark invariably occurs at the same point

In other words the point in the rotation of the shaft at which the magneto spark occurs is not affected by the speed

As the speed increases the igniting ability of the spark evidently increases for its size can be seen to increase until at 1 500 revolution a minute it endures for about 30 degrees of rotation

Throwing the magneto out of circuit and cutting in the battery we will again turn the apparatus slowly by hand The first battery spark will be seen to appear at the zero point and at low speed there is an apparent sheet of flame for the entire 40 degrees during which the timer is making contact

Running the speed up slightly we will see that this sheet of flame is broken up into a series of single sparks which occur very closely together Throwing in the electric motor we will see that at 500 revolutions a minute the distance between the successive sparks is increased very considerably

Each of these sparks corresponds to a single movement of the vibrator during which the battery circuit through the primary winding of the coil is broken

We will see another interesting thing which is that the first spark no longer occurs at the zero point but some degrees after it On increasing the speed to 1 000 and then to 1 500 revolutions we will finally find that during the 40 degrees when the timer is making contact only two sparks are produced which means of course that during that period of time the vibrator has had time to move but twice

The vibrator will make a certain number of vibrations a second say 300 If the timer holds its circuit closed for one second there will of course be 300 sparks produced at the pointer If on the other hand the timer holds the circuit closed for but 1/100 of a second there will be time for but three movements of the vibrator and in consequence only three sparks will be produced Furthermore the first spark instead of occurring at the zero point now app ars some 20 or 2 degrees afterward and we immediately recognize this lag as repr senting th time required for the electric current to perform its various functions between the instant when the timer closes the circuit and the instant when the spark appears

The delay in the production of the spark may be corrected by moving the timer so that contact is made some little time before the spark is actually required The lag due to the work that the electric current must perform is thus overcome mechanically by moving the timer

The moving of the timer however does not correct the shifting in the position of the spark and this cannot be corrected by any means that could be used on an automobile

If the spark is observed it will be seen that it does not always occur at the same point but varies considerably the total variation being 8 or 10 degrees

At the instant when the timer closes the circuit the vibrator contact may also be closed but on the other hand the vibrator contact may be open the blade not having come to rest from the movement caused by the previous closing of the circuit A slight variation in the voltage of the battery will also cause a difference for the lower the voltage the less able will the primary current be to force itself through the winding of the coil

The coil offers resistance of course and it takes certain electrical pressure to overcome it To overcome it more rapidly the pressure must be increased or in other words the voltage in the battery must be raised

If we could change the voltage of the battery to correspond with every change in the speed of the engine we might get better results but we would still need a vibrator blade that we could be sure would be in a true and good contact every time the timer closes the circuit Furthermore we would find it necessary to assure ourselves that the circuit was actually closed at the timer for when the timer contacts are covered with grease or dirt the circuit will not be actually clos d until the moving part of the timer is half way across the timer contacts

The timer that is used with the testing apparatus is operating under perfect conditions and the contacts are clean and uncorroded This is not often the case with the timers that are used on automobiles and consequently the results of the use of such apparatus on an automobile are far worse than are here indicated

Some Unsolved Problems in Electro-Plating*

By George B Hogaboom

As is well known electroplating was the beginning of the science of electrochemistry but it has lingered by the wayside and been neglected as a science and to-day the unsolved problems are many

Electroplating has been looked upon more as a trade than a science and it is only during recent years that much study has been given to it by scientists and that attention has been directed more to the electrolytic refining of metals than to the deposition of metal for decorative purposes The solutions published by Roseleur in 1854 have been improved upon but little and those who have published treatises upon the subject often give only a repetition of his formulæ Nickelplating, as invented by Dr I Adams is probably the only exception.

The field is broad, but its development has been left to the practical man, guided only by rule of the thumb An electrochemist in the plating room of a factory is so rare that it probably can be said without fear of contradiction that they can be counted on the fingers of one's hands The need to-day is mutual assistance in solving these problems and developing of new ideas. To a great extent they are useless each without the others—the plater producing results which he cannot duplicate—the electrochemist creating solutions that are not a commercial success

So many phenomena have been encountered that to include the perplexing problems would necessitate a history of nearly every known solution and finish The varying of the temperature and the electric current often proves a stumbling block and these conditions cannot always be controlled There is a vast difference between producing a homogeneous deposit at a minimum cost from a solution where th amount of cathode surface is being changed every twenty minutes and a solution in which the amount of cathode surface is always the same and the rapid deposit of the metal is more desired than a deposit that can be easily burnished Such would be the difference, for instance between the surface of a sheet of electrolytic copper and that of a cast lead and antimony electroller with its deep reliefs and where a coarse crystalline structure would destroy its beauty In the discussion of electroplating problems it must be borne in mind that a mere deposit of a metal is not all but that the deposit must be soft and smooth and lend itself to a decorative process, the anodes should be capable of being reduced easily, the electrolyte must offer little resistance to the electric current and last but not least to the plater, who hears it so often that it becomes a part of him. the cost must be nominal

DIFFICULTIES WITH SEVERAL METALS

The automobile industry has brought about more than anything else the need of a heavy deposit of brass At present this is done in a solution of cyanide of copper The deposit is not only slow but unsatisfactory, because of what is known as spotting out—a discoloration in spots which appears on the work after it has been polished and lacquered Deposits on cast metal give the most trouble It is probably caused by the acids or alkaline solutions being absorbed in the pores of the metal or in the small blow holes and the deposit covering these holes partially leaving minute holes through which the solution oozes out

Several promising remedies have been suggested and tried such as boiling out in some neutralizing chemical solution or placing in a drying oven for several days but a satisfactory remedy has not been found An acid brass solution would be a great advantage There is an acid copper and an acid zinc solution but no acid brass electrolyte The difference between the deposit from a cyanide and a sulphat of copper solution well illustrates the advantage of having an acid brass solution

The formula for a tin solution published by Roseleur is the most generally used to-day as little if any improvements has been made upon it, although a good solution, which would give a heavy deposit

* A paper presented before the American Electrochemical Society, New York.

is much d sired In Roseleau s solution the electro lyte is not replenished by the anode but by the con stant addition of a concentrated solution This should be overcome and would be appreciated by manufacturers of tin ware While several solutions have appeared from time to time for plating upon aluminium none of them is in general use and a good electrolyte that would deposit gold silver brass or copper so that it would stand burnishing and not peel off in time could be used The success ful removal of a deposit of nickel from another metal without affecting the latter has not been ac complished

UNSOLVED PROBLEMS

To give all the unsolved problems in detail would make a lengthy paper and a simple statement of those most desired will be given An electrolyte that will remove the fire-scale from brass also one that will produce a bright or a matte surface in place of using the present acid dips an electric cleaner that will saponify the grease and take it into solu tion instead of driving it to the top where it has to be constantly removed to prevent it adhering again to the work as the later is removed from the solu tion a heavy deposit of lead on the inside of iron pipes, to prevent rapid corrosion a method to coat electrogalvanized iron or steel with decorative metals without destroying the rust resisting proper ties of the zinc an alkaline nickel-silver solution that can be worked with a low voltage, a method of etching steel without destroying a resistance film of gelatine some alkaline substance that would replace cyanide of potassium This would be universally welcomed

For the above suggestions the writer is indebted to 100 different platers who were kind enough to answer a request for unsolved problems It may be interesting to note that 80 per cent of them requested an acid brass solution

Something About Writing Inks

Notes on Fluidity, Durability, Corrosion and Copying

A GERMAN firm has had the good sense to enlighten the public in general as well as its own customers in particular concerning the properties of writing inks and how to deal with these necessary fluids as follows

Fluidity- Every writing ink loses water by evapor ation and also becomes less fluid by the addition of dust. For this reason only such ink stands should be used as have small openings and these should be closed after use When the ink gets thick it should be replaced by fresh that which is spoiled by sedi ment should be thrown away- it costs only a very small fraction of a cent Ink bottles should be kept closed and in a cool place best inclosed in the ordin ary pasteboard package

Durability -If steel pens pieces of cork or other foreign bodies get into the ink stand they will spoil the best of ink For this reason the stand should be cleaned every time before being filled fresh ink should never be added to old and different kinds of ink should not be mixed Among other signs of spoiling may be mentioned change in color If ink which is kept in a closed bottle and a cool place is spoiled it is either originally bad or is very old and should not have been sold by the retail dealer

Corroding of Steel Pens—The points of the best steel pens would not last more than a week even if that when used with pure water by reason of the friction on the paper In addition to this about 80 per cent of writer hold their pen obliquely so that one point is more used than the other and for this reason the pen is sooner out of service than it other wise would be One should not blame the ink when the pen is used up Those who write all day should change the pen about every three days The expense is but slight in comparison with the convenience hardly a hundred pens a year—only about 50 cents For each kind of ink a special pen should be used

Dirty Pens—The oftener one breaks off his work and lays by his pen without wiping it, the sooner it will be covered with deposit If the ink is properly composed this deposit will however be but slight and cause but little inconvenience The amount of deposit will be influenced more or less by the degree of smoothness of the pen itself

Copies In choosing a copying ink one should consider the following questions

(a) The number of copies required (b) The amount of time available for making the copies (c) *The manner of copying* whether with a platen press or a roller machine (d) The kind of writing and copying papers

And even after paying attention to all these points in the choice of the ink one may get bad copies For this reason the following hints should be ob**served.**

(1) **Copying with the platen press. For this process both log wood and nut-gall inks are suitable The first have a great copying power and last very** long **the second last very long in the bottle, but will** not **copy when the writing is old**

Rough writing papers—not excepting the finest—give poorer copies than smooth ones that are well sized Cheap papers contain wood and most post cards absorb the ink and make copying impossible The thinner the copying paper the plainer and the more legible will the copies be Thick lines copy bet ter than thin ones Old writing must be pressed harder and longer than new Where copying must be done in a hurry (that is in large establishments with a very heavy mail) a copying ink is necessary which gives good copies even with rush work The best copying paper is the so-called pure silk paper for several copies the yellow so-called export paper or Japanese silk paper is preferable The copying paper should be made as wet as possible and super fluous water removed with blotting paper

To obtain several (four to six) copies as many sheets of copying paper should be moistened with out any paper between them as are desired, the extra water is removed by blotting paper and if the writing to be copied is fresh it should be pressed for a minute if old for five minutes At first the pressure should be but slight in order to give the ink time to free itself and enter the different sheets of copying paper Heavy pressure at first gives wide lines and blots on the copy

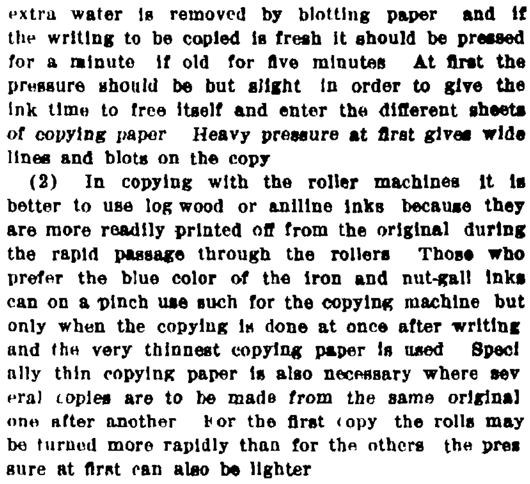
(2) In copying with the roller machines it is better to use log wood or aniline inks because they are more readily printed off from the original during the rapid passage through the rollers Those who prefer the blue color of the iron and nut-gall inks can on a pinch use such for the copying machine but only when the copying is done at once after writing and the very thinnest copying paper is used Speci ally thin copying paper is also necessary where sev eral copies are to be made from the same original one after another For the first copy the rolls may be turned more rapidly than for the others the pres sure at first can also be lighter

It is very important to adjust the machine properly for the ink used If several kinds of writing paper - rough and smooth—or different kinds of copying ink are used in the same office it is just as neces sary to adjust the machine for each as in the case of the platen press

In general the same principles apply to the choice of paper and the processes with the roller machine as for copying in a platen press

A Universal Tool

A NOVEL combination tool designed especially for a private garage has made its appearance Both sides of this tool are shown in the line-cut herewith At



A UNIVERSAL TOOL FOR GARAGES

A is located a forge that is given its blast through a tube leading to the central hole by a small fan in side the tool at *B* that is operated by the crank *C* On the opposite side is located an emery wheel *D* that is also operated by the crank *C* This same crank *C* through bevel gears also drives a chuck *E* that will hold drills or similar tools for machining work while the hand wheel *F* can be used to feed the work up to the tool The chuck can be taken out and the pipe grips *G* and *H* inserted in this hole and another one opposite and the tool used for a pipe vise while an ordinary machinist s vise is located at *I* The top and rear end of one vise jaw is formed into a black smith s anvil *J* while an anvil chisel *K* is supplied to fit the square hole for cutting off work —*American Machinist*

Lacto—A Scientific Summer Drink

THE popularity of summer drinks and ices is such as to make interesting any new addition in the na ture of a frozen product. **Many attempts have been made to present a drink from soured milk flavored with fruit juices with more or less success but in a recent bulletin the Agricultural Department tells of a new frozen product which is called lacto and has been developed toward perfection by the dairy section of the Iowa Experiment Station First buttermilk was used as the basis without entire success, and later skimmed milk which had been soured by a com mercial lactic acid culture was substituted for the buttermilk and combined with eggs, and various fruit flavors giving a product which possessed a deli cate flavor It was found that lacto which may be briefly described as a frozen product made of loppered, whole or skim milk with the addition of eggs sugar lemons and flavoring material has a more pleasing flavor than sherbets and ices and contains consider able more nutriment including as much protein as ice-cream less fat and more acid Out of 179 who sampled lacto 128 pronounced it very good 37 good, 6 fair, and 8 poor and as compared with common vanilla ice-cream 111 preferred lacto 9 considered it** equal to ice-cream and 59 preferred ice-cream Com paring lacto to sherbet, 123 preferred lacto 30 pre ferred sherbet and 26 considered lacto equal to sherbet

Artificial Fur

A NEW French process of making artificial fur which has been patented by its inventor M Marche merits description on account of its originality and ingenuity if not because of its practical importance Small pelts are sewn together stretched with the fur side up on the flat bottom of a large pan and covered with water which is then frozen The cake of ice is removed from the pan and a slice of the exact thickness of the skin is sawed off the bottom of the cake By melting this thin slice of ice the skins destitute of hair are recovered for use in the leather industry The upper part of the cake of ice con taining the hairs is placed with its base near a hot surface until a thin uniform layer of ice is melted and the lower ends of the hairs are exposed The base of the cake is then varnished with a solution of India rubber and after the varnish has become hard the ice is melted In this way is produced a large seamless artificial pelt composed of the natural hair of a number of small pelts or pieces attached to a sheet of India rubber These artificial furs are cheap as the natural skins are saved for other uses, and they are moth proof owing to the substitution of India rubber for animal tissues

Cement for Repairing Stone Slabs, etc —(a) Finely ground granite or standstone or burned magnesite in the absence of the latter ordinary magnesite is stirred with water glass into a paste and quickly worked For all cements it is best to use potash water glass (b) Granite heavy spar precipitated or ground fine as dust and hydrate of lime in equal parts are powdered into a paste with varnish Hy drate of lime with approximately 24 to 25 per cent of water is obtained by using equal parts by weight of hot water for slaking lime allowing it to stand for 24 hours and then straining it off

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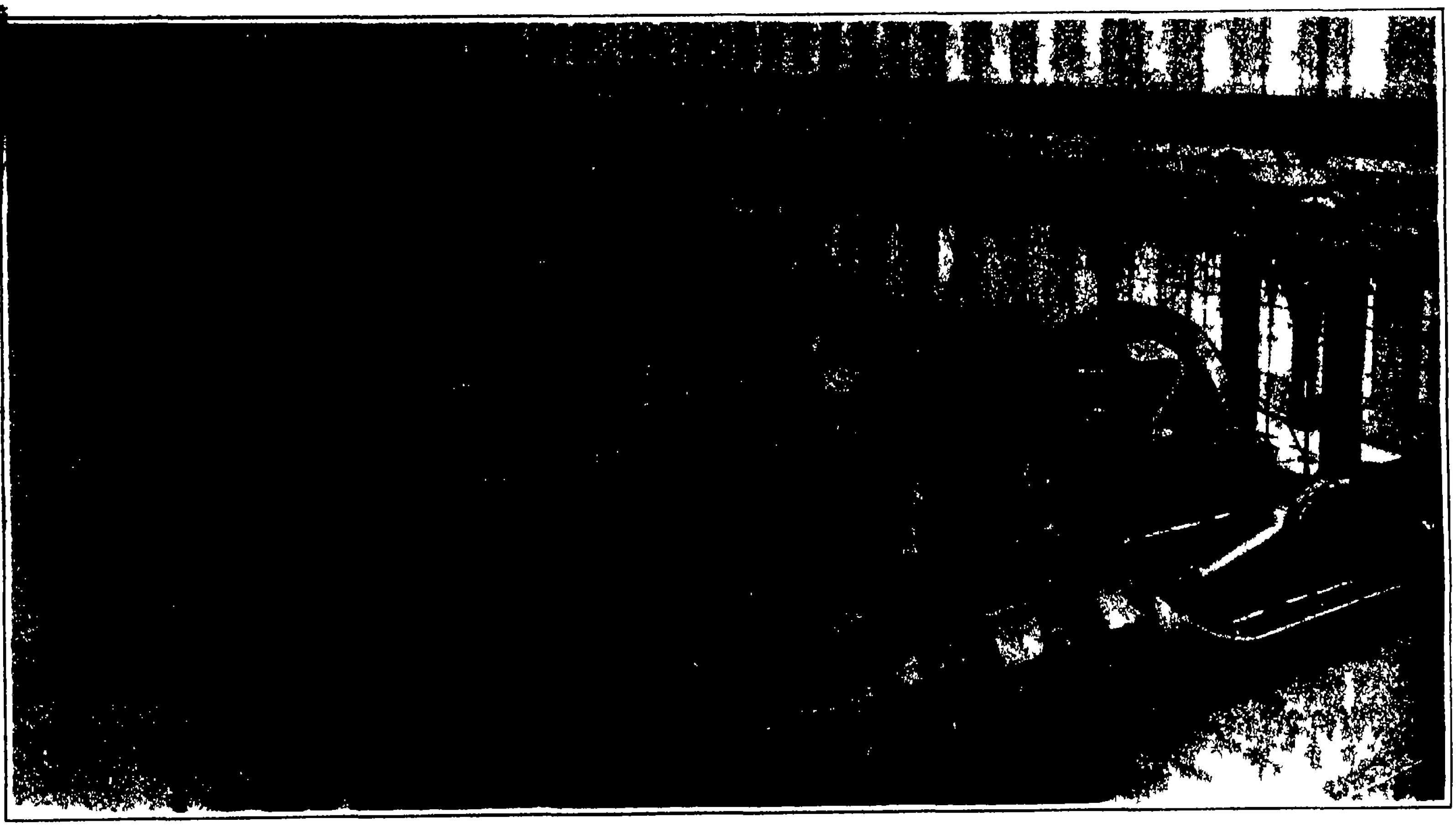

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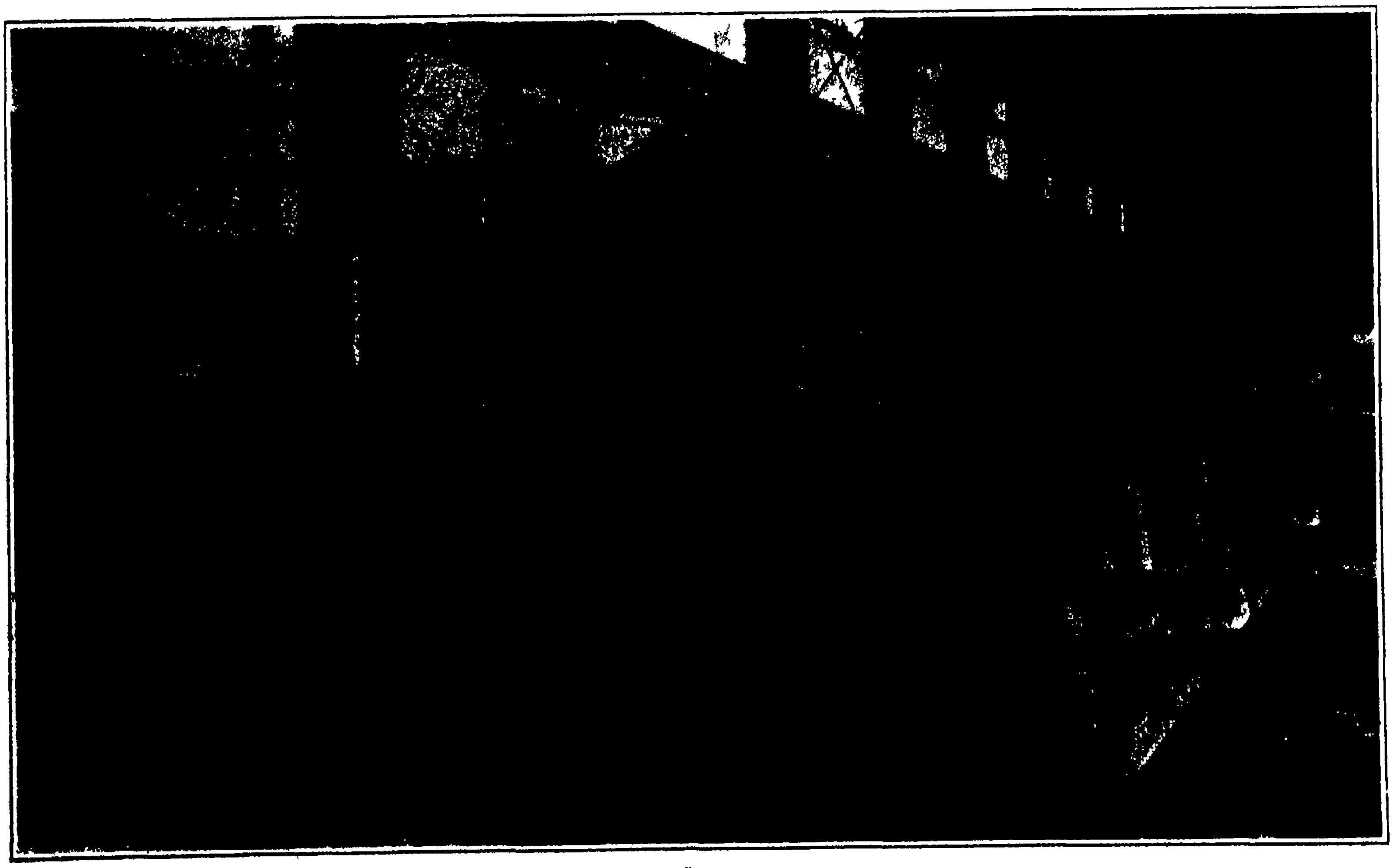


THE SLICK "BLOWING TUB

GIANT GAS ENGINES AND BLOWING TUBS [See Page 329]

The Nature of Invention

How it is Governed by Evolution

By J. Lowy

I

The problem of fathoming the creative activity of the human mind of investigating the causes and the laws which determine the action of this mysterious agency has in all times engaged the attention of the thinkers of the civilized world. In spite of all efforts and astute analysis however no satisfactory conclusion has ever been reached. The reason for this is twofold.

In the first place the case has been regarded as standing more or less by itself and disconnected from other natural phenomena. A kind of sacred fear seems to be felt of attacking it from a purely objective point of view like any other subject of scientific inquiry. The analysis of creative mental activity was reserved to metaphysics and consequently failed to yield a clear result capable of rigid proof and fitting in without straining with the general plan of our knowledge of nature.

The second cause of the failure of the earlier attempts to solve the problem lay in the fact that the methods and results of scientific investigation had not yet reached that state of perfection which they possess at the present time.

We are to-day fully justified in assuming that all the phenomena of which we can become cognizant whether they belong to the domain of matter or to the world of ideas are subject to the universal process of evolution and its laws. If we take a survey of the world in the light of the laws of evolution all the boundaries which seem to divide the several domains of nature seem to be suddenly erased. There is no longer any deep cleft dividing the inorganic from the organic the living from the non living or plants from animals. Not only the concrete objects of nature are seen to be subject to the laws of evolution but also the realm of thought. Thus the great epistemologist E. Mach has said: Ideas are not individual organisms. They are however manifestations of organic life. If Darwin saw truly they too must display a succession of transformations and an evolution. The products of our mind represent special non material branches proceeding from a material trunk the brain and are therefore subject to the same laws as the material members in the chain of evolution.

II

It is proposed in the lines which follow to consider the phenomenon of invention from the point of view of epistemology. We shall see that this activity of the human mind mysterious and unfathomable as it appears proceeds strictly according to rule and obeys the laws of evolution.

The history of civilization shows that man originally was dependent for the performance of his various activities upon natural organs such as the hand the teeth etc. At a later stage man learned to employ articles which he picked up in nature such as branches of trees flints bones turning them into rude implements. Still later primitive man learned to modify articles accidentally found so as to better adapt them to his purposes. In doing this he as a rule copied some existing organic example. Thus for instance he made the ax in the image of the human arm and fist and the saw may be said to have been patterned after the human jaw with its teeth. The process of adapting the implements to their work went on vigorously until finally these artificial aids excelled in usefulness for their particular purpose the organic patterns after which they were fashioned.

The process of adaptation which we term invention takes its course under the guidance of the human will which itself is governed by law. The basis from which the operation necessarily starts is the stock of facts known to the inventor who as a rule proceeds in such logical manner that in most cases we have presented to us the appearance of a methodical process of invention seemingly quite independent of accident. The law and order which holds its sway over invention is not clearly realized by the inventor. A large part perhaps the most essential step in the mental process leading to invention takes place subconsciously. It appears as if some invisible power were guiding the process of thought.

That invention and technical developments follow a prescribed course is proved by many technical products which were not consciously evolved as copies from nature but which were subsequently found through the discoveries of physiology to be analogous in structure to human organs. Thus for example the piano represents a faithful copy of the ear though it was built without any knowledge whatever of the structure of that organ and similarly the camera is a close copy of the human eye. Human creative activity therefore begins with the unconscious copying of nature and unconsciously continues this copying process.

Similar requirements produce in the technical arts the same type of devices as they do in the organic world. The process of invention is a manifestation of natural forces just like all other processes of evolution—the inventor is merely a tool blindly following the law of nature. It is not the inventor who invents but as it were nature which invents in him and which through him and his technical achievements furthers the general process of evolution.

Animal technique also is a proof of the law which guides all technical products. Certain structures built by animals are so well calculated for the purposes for which they are intended and are in such excellent accord with the laws of mathematics and physics that even man could not with the same means produce anything more perfect. We need only call to mind the ant hills of the termites and the hive of the bee. The most important tool which human engineering commands over and above those at the disposal of animals is the weapon of mathematics by the aid of which he shortens the process of evolution. The laws formulated in mathematical guise are however nothing more than the epitome of experiences previously gained by man. Just as animals inherit the accumulated technical experience of their progenitors in their instincts so man hands down his acquisitions in the form of the natural laws and mathematical formulæ discovered by him.

III

We are provided by nature with organs of special sense which respond to a limited number of forms of energy such as for instance light and sound. For a number of other forms of energy we possess instruments the products of technical industry which enable us to detect the presence of these forms of energy. Thus for example the coherer serves to detect electric waves a bismuth spiral discloses magnetic radiation and the barium platinocyanide screen renders us conscious of the X rays. These instruments accordingly fulfill the functions of natural organs. They are like all other technical products nothing more than products of adaptation to nature auxiliaries in our struggle for existence. Where organic evolution ceases technical evolution sets in as its continuation. Instead of improving the eye nature created the telescope and the microscope, instead of strengthening our muscular powers it created working engines. Instead of adding new organs to those which we possess it created for us artificial organs.

Technical and organic evolution merge into each other both serve the same purpose both follow the same laws. The question then arises: Why and by what circumstances is organic evolution separated from technical evolution?

We have seen that technical creations represent products of adaptation of our being to nature just as is the case with our organs. The mode of origin of these products of adaptation we may according to modern scientific views picture to ourselves in this way that the stimuli exerted by external forces upon the existing organism have directly caused the development of such organs as are suited for the perception of the stimuli and the fulfillment of the requirements created by the stimulus. The products of adaptation thus formed serve in the first place the purpose of removing the cause of the stimulus which is usually felt as an irritation and often as a positively painful and dangerous condition. In the same measure as the process of adaptation advances the stimulating action is diminished when the body is perfectly adapted to its environment the stimulus which initiated the process has ceased to act altogether. In this way the stimulating action of light has produced the eye the stimulus of a toxine in the body produces the anti toxine, and similarly water under the influence of high temperature is converted into steam, which accordingly presents itself as a modified form of water adapted to those temperatures.

Every organism is subjected to a variety of forces and the organism is thereby compelled to adapt itself to stimuli. So long as adaptation was possibly only within the limits of organic processes, this adaptation went on excessively slowly, when however the organ of thought the brain had reached a certain stage of evolution these stimuli no longer acted merely upon the portion of the organism directly concerned but also upon the thinking organ. As the result of this any inability on the part of the body to react to the stimulus is unpleasantly felt by the brain which therefore seeks to discover some rapid method of adaptation and overtakes and therefore renders unnecessary organic adaptation. In this way the technical arts came into being as the continuation of organic evolution.

IV

On the basis of conclusions reached so far we shall now have no difficulty in satisfactorily answering a number of questions which arise in connection with the subject of invention. If in this process we divest the inventor of some of the glory in which he is ordinarily enveloped this will be in some measure compensated for by the fact that we shall gain a better understanding of his activity. The honor which we shall then pay him will it is true be far removed from a feeling of sacred fear or adoration but will nevertheless be a perfect and sufficient substitute in asmuch as we shall learn to appreciate the pains the labors and the disappointments of the inventor and shall thus be placed in more immediate human relation to him.

The first fact which strikes us is that no invention however epoch making was purely the product of the head of him to whose name the glory is attached. Every invention represents a temporary end point in a long series of technical perfecting steps which are all connected together like the links of a chain. In many cases the merit of the last inventor upon whom falls the reward and the applause of his fellows and of posterity is considerably smaller than that of many of his predecessors. He a favorite of fortune whose good luck it was to appear upon the scene at a later date has thrown into his lap often through some quite secondary performance on his part the mature fruit the natural outgrowth of the ground prepared by earlier investigators.

The fact that the development of every invention follows a definite law is also the explanation of the frequently observed fact that the same invention is made simultaneously by different inventors working independently. Working on the same basis of previously accumulated knowledge and placed under the same pressure of similar necessities they must necessarily reach the same results representing the last product of evolution. The accusation of plagiarism must therefore be made with great circumspection in matters relating to technical industries.

We can also understand from our present point of view that a man can become a genius of invention only by assiduous labor and study of all that is already known in the field in question. Every invention recapitulates in the head of its creator all the principal stages of its gradual evolution in the past history of the race. The layman as a rule merely rediscovers something which has long been surpassed in the art. For his invention represents the last step in order in the evolution of his knowledge which is not up to date.

To what extent the creative activity of the inventive mind depends on the stimulus of his environment is best recognized from two facts. The first of these is a well known observation familiar in the patent offices of all countries. Generally speaking in every domain of industry there is a steady production of inventors which remains approximately constant at all times. The moment however, that through any circumstances the attention and the thoughts of the world are directed to any particular problem and its solution the number of inventions relating to this particular field goes up by leaps and bounds.

The second fact which is to be mentioned as a sign of this stimulating influence of the environment is the observation that technical men who have proved themselves eminent inventors in their professional practice become almost entirely sterile as soon as they leave the battlefield.

If an invention represents only a small step forward as compared with the known art in a given field, the world is readily able to follow in thought this small step, and the value of the invention is understood without difficulty. If, on the other hand the invention represents a step in the evolution of the art, which is far removed from the last in the same series, then the world, and even the world of experts, often

* Translated for the SCIENTIFIC AMERICAN from *Technische Monatshefte.*

fails to follow the flight of the genius, and the inventor or scientific discoverer reaps, instead of fame, only ridicule and scorn. It is only in later days when a number of re-discoveries of smaller order have covered in a series of small steps the great advance which he had made in one that the world at large realizes the greatness of the genius who by this time is usually dead. In belated token of their appreciation the people then raise a monument to him who can no longer feel the pleasure of this poor compensation for the troubles and pains endured during his lifetime.

Mesothorium and Radiothorium

Substitutes for Radium

The development of radioactive investigations in recent years and especially the increasing employment of radium and its emanation in medicine have created a strong demand for radioactive substances which cannot be satisfied by radium itself. It is very difficult to produce radium in considerable quantities owing to the scarcity of raw material. As substitutes for radium the slowly disintegrating derivatives of thorium which are known as mesothorium and radiothorium naturally suggest themselves. In order to understand the possibility of such a substitution it is necessary to review briefly the chief properties of radioactive substances in general.

Radioactive substances are characterized by the property of emitting peculiar non-luminous rays which are recognized by three principal actions: the blackening of photographic plates, the production of fluorescence, and the discharge of electrified bodies. This discharge is produced by the power of the rays to divide the non-electrified molecules of air into positive and negative parts called ions which serve as conveyers of electricity. If an electrified body is placed in air ionized by the rays of radium the charge is quickly lost. The quantitative study of radioactive substances is based upon this property.

The rays are of three kinds which are called Alpha, Beta and Gamma rays. The Alpha rays are streams of material particles which are positively electrified and are projected with a velocity of about 10,000 miles per second. This great initial velocity, however, is so rapidly destroyed by the resistance of the air that the particles can penetrate only a few inches into the air. In this short journey they exert an astonishing ionizing effect. When the Alpha particles strike a screen coated with zinc sulphide they produce a scintillation due to fluorescence. The investigations of Ramsay, Rutherford and others have proved that the Alpha particles are positively electrified atoms of helium. Every substance which emits Alpha rays is therefore a continuous source of helium.

The Beta rays, like cathode rays, consist of negatively electrified particles, the mass of which is about 1/1800 that of the hydrogen atom. Their velocity is nearly equal to that of light. Owing to their great velocity and small mass the Beta rays are able to penetrate much deeper strata of air and thicker layers of solid substances than the Alpha rays, but for the same reasons they exert a much smaller ionizing effect in traversing an equal distance.

The Gamma rays are similar in nature to Roentgen rays. They easily traverse the human body and thick plates of metal, but their ionizing power is comparatively small.

The phenomena of radioactivity have found a satisfactory and fruitful explanation in the hypothesis of the disintegration of radioactive atoms which was advanced by Rutherford and Soddy. According to this hypothesis the atoms of radioactive substances are unstable and subject to continual decay. The Alpha and Beta rays are fragments of the disintegrated atoms. Radium, for example, emits Alpha rays, i. e., each atom of radium splits up into an Alpha particle or atom of helium and an atom of a new element which, owing to its gaseous nature, is called radium emanation. This emanation in turn spontaneously decomposes and produces a series of gradually disintegrating solid substances which are designated as active deposits. The last of these is the element polonium which was discovered by Madame Curie.

Radium itself is a disintegration product of uranium which gradually changes into radium, passing through the intermediate stages of uranium X and the recently discovered ionium.

The time in which a radioactive substance is half converted into the next member of the series is called the half period or disintegration period of the substance. The various products of disintegration are sharply distinguished by their half periods as well as by their radioactive and other properties. The longer the period is, the more stable is the substance and therefore the more useful for radioactive purposes.

The metal thorium is the first member of another radioactive series distinct from the uranium-radium series. Thorium and uranium are the two primary radioactive elements from which all other radioactive substances are derived. (The very weakly radioactive elements, potassium and rubidium, the position of which is not yet definitely established, are not here considered.)

The disintegration products of thorium, the nature of their radiation and their half periods are given in the following table:

Substance	Radiation	Half Period
Thorium	Alpha	About 3 x 10 years
Mesothorium 1		About 5.5 years
Mesothorium 2	Beta, Gamma	[illegible]
Radiothorium	Alpha	[illegible] years
Thorium X	Alpha, Beta	3.6 days
Thorium emanation	Alpha	54 seconds
Thorium A	Beta	10.6 hours
Thorium B	Alpha	55 minutes
Thorium C	Alpha	About 1 second
Thorium D	Beta, Gamma	3.05 minutes

Of these products mesothorium (or the mixture of mesothorium 1 and mesothorium 2) and radiothorium are comparatively long-lived, so that it is possible to produce them in large quantities in strongly active conditions.

Prof. Otto Hahn, whose article in *Die Umschau* is here condensed, states that he obtained radiothorium in 1905 in Ramsay's laboratory in London from the residues of thorianite and gave it the name of radiothorium because it exhibited all known radioactive properties of thorium to a greatly increased degree. Elster and Geitel and G. A. Blanc simultaneously and independently discovered radiothorium in the mud of radioactive springs. If radiothorium is actually the radioactive part of thorium, thorium and radiothorium should be contained in proportional quantities in the various thorium ores. This is approximately the case according to the experiments of Boltwood and McCoy. The investigation of thorium salts, however, led to the remarkable result that the activity of the salt is in general less than the quantity of thorium demands. Boltwood and Eve concluded from this fact that in the operations by which thorium or its salts are obtained from the ores the radiothorium is partly eliminated. This would be very remarkable in view of the fact that neither Boltwood and Eve nor Hahn was able to separate radiothorium from thorium by chemical methods. It was found also that the half period of radiothorium is about two years, so that a given quantity of radiothorium would be half destroyed in two years but would be reproduced to the same extent from thorium. The weakly radioactive thorium salts investigated by Boltwood, however, did not increase in strength to the extent required by the foregoing considerations. Hence Hahn suspected the existence of an intermediate product between thorium and radiothorium possessing a comparatively long period and chemical *properties different from those of thorium and radiothorium*.

Hahn then undertook a systematic study of various freshly prepared pure thorium salts and also of old thorium salts. He found that the radioactivity of the fresh salts was proportional to their percentage of thorium, but that the radioactivity gradually diminished. Preparations four years old were scarcely half as strong as fresh preparations. Still older preparations, on the contrary, showed increased activity. These phenomena can be explained by assuming that in the preparation of the thorium salts a hypothetical substance intermediate between thorium and radiothorium is eliminated, while the radiothorium already produced remains associated with thorium. In the absence of its hypothetical parent substance the radiothorium gradually diminishes and the activity of the preparation would fall to zero except for the fact that the intermediate product is gradually regenerated. After a time, therefore, the quantity of radiothorium increases and the radioactivity increases with it.

If this view is correct, the hypothetical intermediate product should be found in the residues left in the preparation of the thorium salts, and there it was found by Hahn, who named it mesothorium. The discovery was confirmed by Boltwood and McCoy. Both McCoy and Hahn computed the half period as about 5.5 years.

Preparations were then made to obtain mesothorium in quantity from residues left in the commercial preparation of thorium salts. In this process it was necessary to treat enormous quantities of material as appears from the following comparison. One milligram of radium bromide is about as active in penetrating rays as six kilograms of thorium oxide. The ordinary thorium ore monazite sand contains four or five per cent of thorium oxide, hence from 120 to 150 kilograms of monazite are required to produce a quantity of mesothorium equivalent to one milligram of radium bromide, even if no loss occurs.

The thorium residues are so abundant that strongly radioactive mesothorium preparations can be obtained by working up sufficiently large quantities. In this way about 2.0 milligrams of mesothorium equal in activity to pure radium bromide have already been produced, and a few milligrams of a substance *four times as strong as pure radium bromide* have been obtained. As radium bromide is about 6,000,000 times as active as thorium oxide, the mesothorium preparation just mentioned is about 24,000,000 times as active as thorium oxide, or 50,000,000 times as active as thorium nitrate, the ordinary commercial salt. The action of the strong mesothorium preparations is apparently identical with that of pure radium salts. This statement, of course, refers only to the more penetrating rays, as mesothorium does not emit Alpha rays. The Alpha rays of radium, however, are stopped by the ordinary glass container.

The production of mesothorium furnishes the possibility of obtaining radiothorium in very active form. *It is found impossible to separate radiothorium from thorium, but it can easily be separated from mesothorium as fast as it is formed.* If the radiothorium is not separated its action is added to that of the mesothorium. Radiothorium is similar in property to actinium which has been obtained only in very small quantities. Owing to the short life of thorium emanation *neither radiothorium nor mesothorium is available for certain purposes for which the comparatively long-lived radium emanation is employed*. It is possible, however, to separate from radiothorium the intermediate product thorium X, whose period is about equal to that of radium emanation and which is a continuous source of the short-lived thorium *emanation*.

As the period of mesothorium is 5.5 years and that of radiothorium is 2 years, freshly prepared mesothorium preparation increases in strength for about three years and by about 50 per cent, and then becomes weaker. The activity falls to its original value in about 10 years and to half that value in 20 years. *The fact that the activity diminishes so slowly and never reaches zero* is due to the presence of a small quantity of radium derived from the uranium contained in the monazite. As mesothorium, like radium, belongs to the group of the alkaline earths the two elements remain associated.

The production of mesothorium and radiothorium has the great disadvantage compared with that of radium that inordinately large quantities of material must be worked. One ton of uranium residues yields about one-third gramme of radium bromide, but one ton of thorium residues yields less than ten milligrams of a mesothorium preparation equal in strength to radium bromide. Nevertheless mesothorium can be prepared more cheaply than radium because uranium residues are valuable while thorium residues can be had in large quantities and have hitherto been a waste product.

Germany is the largest producer of thorium in the world and is able to furnish annually a quantity of mesothorium equivalent to more than *ten grammes of pure radium*.

Ancient Roman Mining

Interesting discoveries have been made in the San Domingo mines of Spain that show the methods followed by the ancient miners.

In some of these mines the Romans dug draining galleries nearly three miles in length, but in others the water was raised by wheels to carry it over the rocks that crossed the drift. Eight of these wheels have been brought to light by men working in these same old mines. The wheels are made of wood, the arms and felloes of pine and the axle and its support of oak, the fabric being remarkable for the lightness of its construction.

It is supposed that these wheels cannot be less than 1500 years old, and the wood is in a perfect state of preservation owing to its immersion in water charged with the salts of copper and iron.

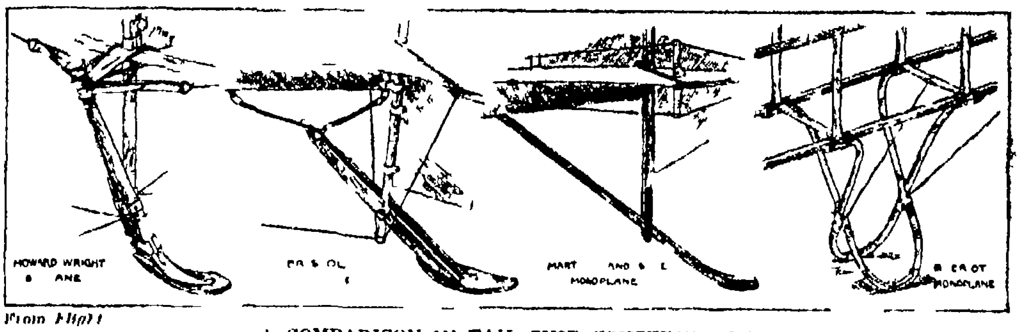
From their position and construction the wheels are supposed to have been worked as treadmills by men standing with naked feet on one side. The water was raised by one wheel into the basin from which it was raised to another stage by the second wheel, and so on for eight stages.

Aeroplane Under-carriages.*

Some Recent Designs

No better example of the manner in which practical considerations relating to matters of an entirely extraneous character often affect the direct solution of theoretical problems could easily be found than may be observed in the influence of the under-carriage on the evolution of the flying machine. It is true of course that aeroplanes must always alight on *terra firma* sooner or later, but the ability to do so gracefully and harmlessly might at first have been far more conveniently deferred to a later date had it been possible to do so. In those days when the ability of a machine to fly at all was the main question of importance. However, nowadays the marked success of passenger-carrying vehicles of the air and the rapidly increasing evidences of a more or less immediate definite utility in aerial navigation demand the fitting of perfected landing arrangements, and the time and care bestowed upon the design of the under-carriage no longer seems out of place. From the very beginning how very necessity forced this same purely mechanical problem on the attention of those who sought to fly. The inventor might have ideas galore, but before he could test the least of them it was always necessary to come down to earth in order to undertake the practical design of some suitable supporting member capable of preserving a machine during its all too protracted peregrinations on the ground. All kinds of different schemes have been tried at one time or another. Sir Hiram Maxim built a railway for his immense aeroplane of 1894. Langley built launching ways over the waters of the Potomac for his double tandem monoplane, which might well have been the first machine to fly in America. Lilienthal and the early pioneers of gliding carried their machines under their arms so that they might use their own legs for starting and alighting. The Wright brothers, who having adopted the prone position on their gliders used to have their machines carried by assistants for the purpose of launching, subsequently improvised a single starting rail when they developed their power-driven flyer. All special devices such as these served their purpose for the time being and to the extent that as they were used they were justified by the facility that they afforded the experimenters to get ahead on the real purpose of their undertaking, which was to learn something about the dynamic navigation of the air. It was always obvious that so soon as the practice of the art of flying should attain to any measure of popularity that the aeroplane of that day would have to be a self-contained machine capable of safely rising from and alighting on the ground by means of its own under-carriage.

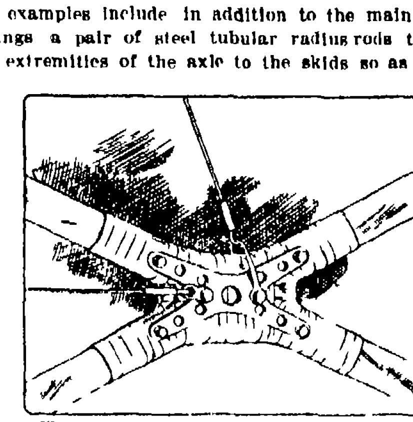
Considering the nature of early aerodromes and the conditions of the ground on which pilots must at all times be prepared to bring down their machines, it is really remarkable how satisfactory the simple and somewhat crude designs have proved to be. Nothing could well be less complicated than the conventional Farman type of wheel and skid combination that has been popular for over a twelvemonth. Examples of it may be seen on the Bristol biplane, Grahame-White biplane, Howard Wright biplane, Baby Wright wire-spoked pneumatic shod wheels. The axles are lashed at their centers to the skid by an elastic strap, which forms the sole flexible suspension in the system. If these elastic springs break the machine settles down on the skids proper, but so long as the elastic holds account of the use of stranded steel cables in place of rigid tubular steel radius-rods. On the Baby Wright biplane the elastic spring differs from the ordinary type, for here the axle carries a bracket fitted with parallel bolts, three on either side of the axle, and



From Flight

A COMPARISON IN TAIL SKID CONSTRUCTION

the weight is carried by the wheels. Under the tail plane is a small skid to protect the tail plane from coming in contact with the ground. It is a minor and comparatively insignificant structural feature, but a study of its details often reveals many points of interest. In respect to the mounting of the axles to the skids on the Farman type under-carriage the design generally only varies in minor details, for all the examples include in addition to the main elastic springs a pair of steel tubular radius-rods that tie the extremities of the axle to the skids so as to pre-



From Flight

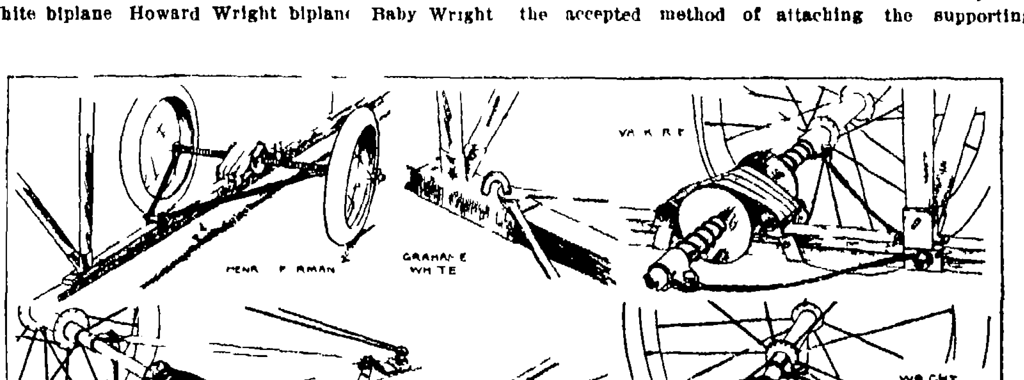
A CROSS JOINT ON THE MAURICE FARMAN OUTRIGGER

vent it from slewing, and some form of lateral spring to keep the skid more or less under the center of the axle. On the genuine Farman these springs are of the steel helical type and surround the axle. On the Bristol biplane elastic strips are used to tie the extremities of the axle to the skid instead.

A similar arrangement carried out in a particularly neat manner is employed on the Howard Wright biplane, where can be seen an excellent example of the accepted method of attaching the supporting each bolt carries a separate broad elastic band that is anchored to the corresponding member on the skid. The radius-rods on this very neatly constructed carriage too are brazed together so as to form a rigid A-shaped member, the apex of which is flexibly attached to the skid by an eye-bolt.

In all machines mentioned the skids themselves are fairly short, with more or less upturned extremities projecting a matter of perhaps 3 feet in front of the main planes. On the Maurice Farman aeroplane the under-carriage is distinguished from the Henry Farman by the continuation of the skid members as far as the elevator outrigger, on the lines originally introduced by Sommer. The Humber biplane is another example of this form of construction, but in this particular machine the skid extensions form separate pieces fastened in place by bolts to the skids proper, whereas on the Maurice Farman the skid is continuous. This Maurice Farman carriage is also particularly interesting on account of the joining in the outrigger framework of which the skid forms a part.

The other outstanding examples of this principle of carrying the skids right forward to the elevator are to be found in the Valkyrie and the Sanders aeroplanes, the former being an altogether distinctive type of under-carriage due to the peculiar nature of the machine itself. It is interesting however to compare the Valkyrie with the Sanders, in which the principal members of the under-carriage consist of two very strong girder type skids braced by wood struts and diagonal steel tape. In the Sanders biplane the under-carriage is distinctly a self-contained unit, whereas in the Valkyrie, where the same general principle is in use, the carriage seems to be so much more an incorporated part of the machine as a whole. It is not easy to suggest an alternative method by which the Valkyrie machine could be put together without a carriage of its present form, and this after all is some indication of a homogenous design.



From Flight

COMPARATIVE DETAILS IN THE CONSTRUCTION OF THE FARMAN TYPE WHEEL AND SKID COMBINATION

biplane and Dunne monoplane. Each of these machines has, except possibly for minor details, the conventional form of this type of under-carriage from the two strong ash skids placed well apart to give a wide base of support and trussed by vertical and oblique struts with wire bracing to the main spars of the lower plane. Each skid carries a short steel axle on the extremities of which are mounted two brackets for the main elastic springs. In most cases the tubular radius-rods are fastened to the skids by a bolt passing through the angle plate, but on the Grahame-White under-carriage this bolt is replaced by a U staple.

The Valkyrie monoplane, which has the Farman type wheels and axles on an under-carriage of entirely original design, illustrates an example of the steel helical lateral spring and is further interesting on

In all machines thus far compared the under-carriage has been characterized by the presence of two skids and four wheels, but among monoplanes it is uncommon to find more than a single axle in conjunction with a central skid. An excellent example of this form of construction may be observed in the Handley Page monoplane, which has a central skid of channel section timber and a very long axle also of timber, the flexibility of which constitutes the suspension. Above the axle rise two masts forming an A-type frame for the support of the fish-like body, and it may be observed that this frame is continued right through the body to form a mast for the bracing of the wings. In the Bristol monoplane, which is likewise characterized by a central skid and single axle, the body is supported by a pair of inverted A-type frames, the apices of which rest upon the skid. On this machine, however, the axle is not so long, and elastic suspension is employed as a means of attaching the axle to the skid. On the Handley Page monoplane these two members are rigidly connected. Another feature of the Bristol monoplane is the use of two long crutches to form struts between the extremities of the axle and the upper beams of the body, to which they are attached by elastic shoulder straps. Another interesting comparison with both the above-mentioned carriages is afforded by the Nieuport, which is similar in principle to the Bristol, in so far as the body is attached to the skid by two inverted A-type frames, but differs from both the Bristol and the Handley Page in having a tubular steel skid and an axle that is formed by a laminated steel spring. In the flexibility of this spring the axle is obviously similar in principle to that on the Handley Page.

*Reprinted from *Flight*.

Another variation in the central skid category is the class that is formed by machines like the Antoinette, in which the axle and skid are entirely independent structures, the skid taking the form of a projecting foot under the fore part of the machine only. An example of this system of construction more or less as introduced on the Antoinette is to be seen on the Martin Handasyde monoplane where however the suspension of the axle itself embodies many original details. In this machine the weight is carried on four elastic springs that are grouped round the central tubular steel column situated vertically beneath the body. On this column slides a cross head to which the springs and diagonal struts of the axle are anchored and a corresponding cross head at the base of the column forms the point of attachment of the inner ends of the divided axle itself. A modification of the original Antoinette combination is represented by the Kny aeroplane in which the foot like skid is hinged to the axle but this particular carriage is properly speaking in a category by itself because the axle is rigidly trussed to the body and the wheels are mounted, too on the axle by radius brackets fastened by coil springs. A massive wooden foot is attached to the body by a telescopic strut fitted with a helical spring buffer.

The Cody biplane also belongs to the central skid type of carriage. In this machine the axle is unusually short and guard wheels are fitted to the extremities of the lower main planes on that account. The suspension on this machine is effected by two very large and very long helical steel springs which extend from the axle to the main frame and when the machine is in flight the thrust of these springs is transferred from the axle extremities to the diagonal wires that brace the forward main spar in the lower plane.

The most elaborate looking carriage of all is that on the Bréguet biplane which really constitutes a three-wheeled under carriage on which the machine is entirely supported for there is no protective skid under the tail. Two of these wheels all of which are of very small diameter are mounted on the extremities of a rigid axle that is attached to the body by two telescopic struts fitted with helical spring buffers and oil dashpots. This axle also carries two short skids projecting forwards and the front ends of these which are normally quite clear of the ground are fastened to the same point of the body by rigid tubular steel struts. Between the base of these latter struts is another tubular steel axle forming part of a horizontal triangular frame at the forward apex of which is a wooden foot. The foot is hinged to the frame and a rearward extension thereof carries the third wheel of the set of three on which the machine is mounted. This wheel occupies a position in the center of the afore mentioned triangular frame work and being interconnected with the steering mechanism may be moved anywhere within the space thus defined. The forward apex of the frame is like the main axle attached to the body by a telescopic strut.

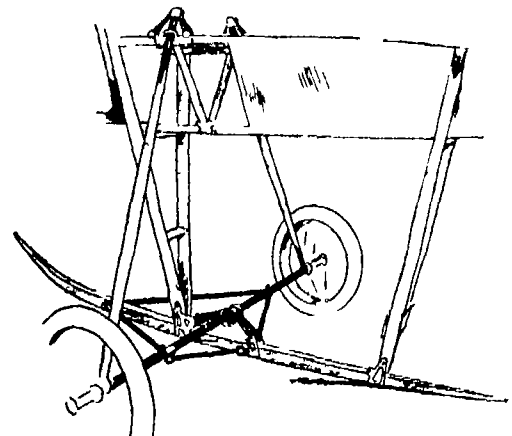
A machine that stands in a class apart so far as its carriage is concerned is the Blériot which has been little altered except in the matter of refinement since it was initially designed. In this machine the carriage is primarily a rectangular frame formed by top and bottom flat beams separated by two vertical struts and carrying between the extremities two vertical tubular steel columns. The body rests on the top beam while the lower beam forms the base of the structure and the point of attachment for the steel tapes that truss the wings. Attached to the steel columns are hinged triangular brackets that support the wheels the hubs of which are tied together by an ash strut and braced diagonally to the base of the carriage by wires anchored to rubber springs. This latter construction is for the purpose of keeping the wheels in line with the direction of motion. Additional struts rise from the base of the carriage to assist in the support of the engine frame which is situated in front of the body and also for the support of the body at a point farther to the rear but on this machine there is no skid of any description other than the simple little bamboo cross beneath the tail.

Our Iron Ore Reserves

A COMPREHENSIVE review of the situation with regard to the supply of iron ore in the future forms part of Prof. J. A. Kemp's paper Geology and Economics. The data are of such interest that a somewhat detailed quotation seems to be in place and is given below.

"In 1905 Prof. Törnebohm the eminent and greatly esteemed former director of the Geological Survey of Sweden, assigned to us a reserve of only one billion and sixty millions of tons. Obviously at an annual production of over fifty millions this reserve would only last twenty years. Much opposition arose at once however, to Prof. Törnebohm's data because from them had been omitted the red hematites of Alabama, which can be very accurately estimated, and which of themselves are thought by competent observers to have a half billion tons for the future. Additional modifications must also be introduced when we properly appreciate the downward tendency of workable percentages. The lower the percentage of iron which we require in the product of our mines the greater the amount of ore which at once becomes available. This is peculiarly true of iron because of its very wide general distribution.

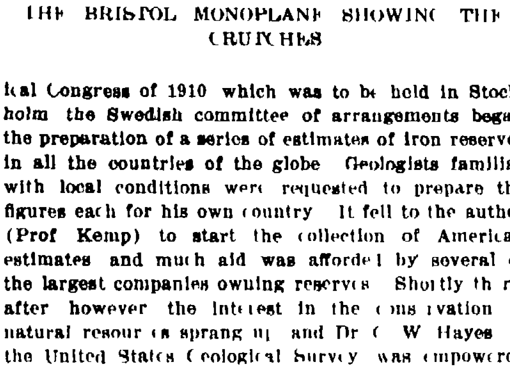
In 1907 in anticipation of the International Geolog-



From *Flight*

THE BRISTOL MONOPLANE SHOWING THE CRUTCHES

ical Congress of 1910 which was to be held in Stockholm the Swedish committee of arrangements began the preparation of a series of estimates of iron reserves in all the countries of the globe. Geologists familiar with local conditions were requested to prepare the figures each for his own country. It fell to the author (Prof. Kemp) to start the collection of American estimates and much aid was afforded by several of the largest companies owning reserves. Shortly thereafter however the interest in the conservation of natural resources sprang up and Dr. C. W. Hayes of the United States Geological Survey was empowered



From *Flight*

A COMPARISON OF SOME GIRDER SKIDS

to use all the resources of this great organization in assembling data on iron. In this way figures as reliable as can be expected are now available. We learn from them that we may consider three and one-half billions tons of 50 per cent ore as assured in the Lake Superior region. Of this great total three billions one hundred millions are in the Mesabi range of Minnesota. At thirty millions of tons per annum the present output of Minnesota we have a reserve for a century.

On the other hand if we drop to 40 per cent or slightly below still however remaining a few per cent above the Alabama grade the drill holes show above depths no greater than those already reached in some mines two or three hundred billions of tons of siliceous hematites giving amounts practically inexhaustible.

In the Alabama ore beds we feel assured of five to six hundred million tons of the grades now utilized and there may well be twice that number. The conservative estimate would afford enough to last at the present output of that State longer than a century. In addition there is much reason for thinking that there may be two or three times as much.

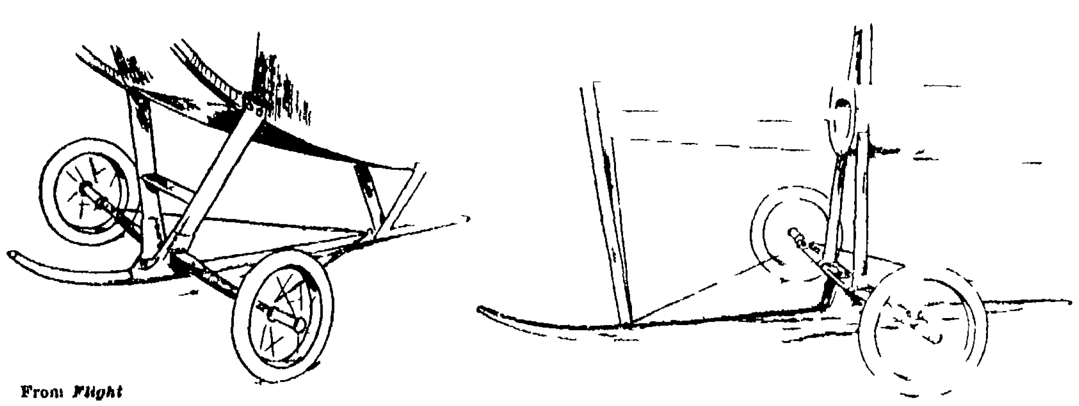
Speaking for the country as a whole we may say that there is an assured and demonstrated supply at present rate of output and at present percentage of yield for about a century. There is furthermore a less accurately measured but still very probable addition when we allow for lower grade but still practicable ores which will be sufficient to last at present rate of production for fifteen hundred years to come.

If however production increases as indeed it may with a rapidly growing population and if in this way heavier and heavier drafts are made upon even this great reserve where shall we look for more? There may be some new discoveries within the United States but at present it is impossible to speak definitely of them. We may ask if there are other supplies in neighboring lands. To this question we may answer yes. Along the north shore of Cuba toward its eastern end and near the sea three areas of what formerly appeared to be a barren ferruginous soil have been discovered and tested so that we now know that there are two to three billions of tons of a very pure iron ore which when deprived of the large percentage of water which it contains—a cheap and simple process—will yield from 40 to 45 per cent iron. This variety of ore already begins to enter our ports and the deposits will undoubtedly contribute in no unimportant way to the output of our furnaces.

The report of the International Geological Congress has shown further that in Newfoundland there are very probably more than three billions of tons of red hematite whose present yield averages 54 per cent. From Brazil moreover in the State of Minas Geraes but pretty well back from the coast and not yet opened up by rail as estimated by Dr. O. A. Derby there are from five to six billion tons of 50 to 70 per cent ore awaiting the drill and the steam shovel. Ore from Brazil faces a long sea voyage but the grade is rich and the iron masters of this and other countries are looking upon these deposits as well within the possibilities of the future. Ocean freights are kept at very reasonable rates in later days and on cargo on a steam ship even so low priced a commodity as iron ore if of good percentages and cheaply mined and taken relatively great distances. This is demonstrated by the shipment this year from the mines of Kiruna 11? miles within the Polar Circle in Lapland of 300 000 tons of ore 113 miles to the Norwegian coast by rail and over 4 000 miles to Philadelphia by sea with no great prospect of a return cargo. These shipments also demonstrate that we are not without the range to which European ores may be shipped when exceptionally rich. Some portion of the vast ore body of Kiruna with its demonstrated [illegible] millions of tons of 65 to 69 per cent ore will also reach American furnaces.

But even were our actual ores of present grade to become exhausted iron as a metal would not fail. The basic rocks with their low percentages still remain. The traprock of the Palisades contains 7 to 8 per cent of metallic iron a value that is far above the general yield of our copper ores in the red metal.

Iron therefore will never fail. It will probably not change in its general relations to modern conditions for a very long time to come so far as its ores are concerned. We may have greater anxiety about the supplies of coking coals than about the iron ores but there are always such possibilities of improvements or changes in processes that no one can justly give way to unqualified forebodings.



From *Flight*

A COMPARISON OF THE NIEUPORT LAMINATED STEEL SPRING AXLE AND THE HANDLEY PAGE FLEXIBLE WOODEN AXLE

Stone Paste for Casting.—Boil linseed oil with paper waste or bookbinders paper trimmings for 24 hours. Pour the mixture into molds. Dissolve glue in hot water, mix the solution with linseed oil washed chalk and paper pulp.

Mechanical Handling of Materials*

The Progress of Recent Years

By Richard Devens

WITHIN the last few years some of our railroad industrial and steamship companies have begun to realize the important part mechanical transference plays in the quick and economical handling of material The most efficient advances have been made in the handling of bulk material such as ore coal and grain while package freight comprising boxes barrels bags and other packages which make up the load of a freight car or the cargo of a steamship has just begun to receive serious consideration

EARLY ADVANCES IN IRON ORE HANDLING

It is no doubt a fact that the proficiency in handling bulk material was due to the difficulties to be overcome in the transportation and handling of iron ore to the center of the iron industry I have reference to the iron ore that was discovered in the Lake Superior country The first problem was the transportation and this was overcome in 1855 when the Federal Government completed its first system of locks at the falls of the St. Mary's River at Sault Sainte Marie Mich The second problem was the loading and unloading of the vessel The loading was readily accomplished by the building of a long line of pockets on a dock extending into the lake and the equipping of each pocket with chutes The pockets were of such height that the ore would flow from them over the chutes and into the vessel by gravity The railroad cars of the bottom dump type were brought over the top of the pockets and dumped into them

It is interesting to note that the method used in the first loading dock is the one on which all docks have been constructed since The unloading has been the most difficult to accomplish in a quick and economical manner The first vessels to carry iron ore were not constructed for the purpose and while they carried some ore in the hold most of it was carried on deck When it was carried in the hold it was hoisted to the deck by horse power dumped into barrows and then like the deck cargo wheeled ashore

The next step was the substitution of a small hoisting engine for the horse power This early method was in operation many years and it was not until the dock managers were forced into it by the great expense in carrying large storage on the dock that any mechanical devices were attempted

THE FIRST MACHINE FOR ORE LOADING

A cableway machine built and erected at Cleveland Ohio in 1880 under Alexander E. Brown's design and supervision was the first mechanical plant The next machines were of the bridge type The method of handling the iron ore over either the cableway or bridge was to fill iron buckets by hand in the hold of the vessel and then hoist them by the machine and dump them automatically into railroad cars or storage In the hold there were from 12 to 15 shovelers to each machine and there were two men on the machine one an operator and the other a fireman

Both of the above equipments were a great improvement over the early methods and handled the iron ore in a satisfactory manner yet they did not cut down the cost of the hand labor in filling the buckets in the hold This was a very large part of the cost of unloading An automatic filling bucket had been worked successfully for a number of years in coal and similar soft material but on account of the hard and lumpy nature of the early iron ores it could not be operated in them

THE GRAB BUCKET MACHINE GREATLY LOWERS COST

With the use of the soft Mesaba ores interest in the automatic filling or grab bucket was renewed and about ten years ago the first successful grab bucket machines were erected and operated at the Illinois Steel Company's plant at Chicago by Hoover & Mason This plant was designed to unload from the vessel direct into railroad cars The success of this plant was the beginning of the present methods of unloading iron ore There have developed two types of grab bucket machines—one with the grab bucket suspended from wire ropes and the other with the grab bucket carried on a rigid arm

The cost of filling the buckets by hand was about 13 to 15 cents per gross ton and the cost of hoisting and dumping into railroad cars or storage from 1½ to 2 cents per gross ton making the total cost of unloading from 14½ to 17 cents With the grab bucket machines this total cost has been reduced to from 1 to 2 cents per gross ton depending on the distance the ore is carried from the vessel

The hand filled buckets were of about one ton capacity as this size had been found to be the most practical for filling and handling in the hold With the grab bucket the size is only limited by the dimensions of the hatch and the shape of the vessel The first grab buckets for iron ore were of five tons capacity but since then machines have been built to handle seven and a half ten and fifteen tons

Besides reducing the cost of unloading the ability to handle in larger units has reduced the time Whereas with the hand filled buckets to unload a 6 000-ton vessel was a question of days it is now only a question of hours The steamer Morgan of the Pittsburg Steamship Company with a cargo of 11 319 tons of ore was recently unloaded at Fairport in five hours and fifty-eight minutes The work was done with six Brown electric unloaders

INCREASED NUMBER OF VESSEL TRIPS

These improvements have also increased the earning capacity of the vessel by making possible a greater number of trips during the season This is seen in the following comparative statement for the years 1906 and 1910 showing the average stay at upper and lower ports of the vessels of the Pittsburg Steamship Company

	Year 1906		Year 1910	
	Hr	Min	Hr	Min
Average stay in lower lake ports	36	15	22	22
Average stay in upper lake ports	22	25	12	22
Average time spent in port receiving and discharging cargoes	58	38	34	44
	Gross Tons		Gross Tons	
Average cargo carried	5 954		6 634	
Largest cargo carried	13 333		13 296	
	In 70 Min		In 45 Min	
Fastest loading record	9 277		9 788	
	Tons per Hr		Tons per Hr	
Rate of fastest loading record	7 288		13 051	

EUROPE AHEAD IN HANDLING PACKAGE FREIGHT

In the foregoing I have outlined the development of handling bulk material using iron ore as an example The handling of package freight has not been brought to the same degree of perfection In many manufacturing concerns mechanical devices have been installed to reduce the cost of handling and to hasten the transportation of their products but for quick and economical handling of freight at shipping docks and railroad terminals little has been done in this country In Europe greater advances have been made due largely to the encouragement given by the city or government which frequently itself equips the docks At Hamburg Antwerp Bremerhaven Glasgow London Manchester Havre and many other ports are found mechanical appliances each to meet the local requirements but all aiming to reduce the number and cost of handlings

In England at the freight stations and warehouses the practice is to instal jib cranes so arranged that they can serve all the floor space from car or wagon In this country many of the railroads have put in hand cranes of the pillar or bridge type for handling freight from cars to wagons or *vice versa* but they are mostly for heavy lifts and are slow in operation and cover only a limited area

Some of the railroads have put in electric cranes in their freight yards and water terminals for example the Pennsylvania Railroad Company on its Greenville docks the New York Central & Hudson River Railroad Company at Port Morris the Philadelphia & Reading Railroad Company at Port Richmond and the Central Railroad of New Jersey at Communipaw

PACKAGE FREIGHT AT TERMINALS

Many of the railroads are coaling their locomotives at greatly reduced cost and time by mechanical appliances but the question of handling their package freight at terminals is still open Most managers have known that there is a great loss of time in transferring freight at terminal and intermediate points but few seem to realize the high costs that this involves

Perhaps the most complex movements in the handling of package freight are at the large steamship piers due to the great carrying capacity of the large vessels, the many consignees each having his allotted space and the limited floor area that has to be cleared quickly to make room for the next vessel The larger railroad terminals also have their many consignees but the floor area is not so restricted

The placing of the packages in the proper space is done by the hand truck A sling load from the vessel or a railroad car may contain packages for several consignees The truck man cannot wait to sort as he receives them, so must load his truck with them as they come This means a long travel to get the packages to their allotted space In order to tier them several more handlings are necessary All this leads to congestion and increasing cost per ton This is further affected by the rise in the cost of labor materials rent and larger terminals Each terminal is a problem in itself as is each manufacturing establishment so that it is necessary to make a careful study of the conditions to be met before any mechanical method can be proposed

In the last thirty years there has been a steady increase in the capital invested in manufacture which means an increase of tonnage of all kinds of package freight carried by the steamship and railroad companies To meet this, the railroads have increased their rolling stock and either enlarged their terminals or built more In large cities this has been at great cost for land and buildings The method of handling the freight has remained the same.

At a terminal there are two kinds of freight—outbound and inbound The outbound is transferred from wagons into the outbound freight house and thence to the railroad cars or directly from the wagons to the cars The inbound is *vice versa*

All the above movements except between wagons and cars involve the sorting of packages and distributing each to its designated space It is also necessary to transfer cars from one freight house to the other as the use of the hand truck necessitates bringing the cars to the freight

REQUIREMENTS IN FREIGHT HANDLING

A mechanical equipment to be satisfactory must be able to distribute the outbound and inbound freight simultaneously there should be no rehandling and every square foot of floor space should be served with a single handling All motions of lifting and conveying should be done by power The machinery should be designed to give the greatest lift required and to transfer to any reasonable distance and then tier or lower into cars Continuous operation should be sought for to avoid delay

No part of the transference should be along the floor and the equipment should not take up any floor space that can be used for other purposes All movements of the mechanical equipment should allow of the assorting and distributing according to classification and allotted space readily and quickly There must be reserve capacity to prevent congestion in case of extra demands The justification for the investment of the mechanical installation lies in the reduction of cost and the saving of time in handling The expense should be in proportion to the size of the terminal

There are many companies in this country engaged in the manufacture of hoisting and conveying machinery While perhaps no one makes all the necessary appliances yet a combination of their product could be used to fill the special requirements of each terminal point

HOW TO MEET THE PROBLEM

Fully to cover the floor space and obtain all the different requirements for the satisfactory handling of the package freight three units or different types of conveying machinery are necessary These are the single rail electric trolley the bridge traveler and the cross traveler The electric trolley is the actual load carrying part of the equipment the single rail bridge traveler and cross traveler furnishing a combination of loop track system on which the trolley can reach any part of the area to be covered All movements should be so regulated that there will be no interference, and many trolleys can be in operation following one another Each trolley can draw a number of trailer trolleys, so that many packages can be hoisted and transported under the control of one man. This arrangement allows many loads to be transported in close sequence simultaneously, and with maximum hoisting and traversing speeds, gives the greatest range and capacity at a minimum of labor and maintenance At some freight terminals it may be necessary to have, in combination with the above

*Presented before the Congress of Technology Boston April 11th 1911 at the fiftieth anniversary of the charter of the Massachusetts Institute of Technology

mechanical conveyors motor trucks on the surface in others, belt conveyors. There is no doubt that some such scheme as outlined above when properly carried out to meet the special requirements at any terminal would materially reduce the time and cost involved in the present method. This has already been exemplified in the handling of bulk material.

Considering the special attention now being given this question by several engineers and the interest shown by many steamship and railroad managers it can be safely stated that within the next few years great changes and developments will be accomplished.

A New Gas Machine

Use of Gasoline for Production of Gas for Light, Power and Heat

THE consumption of gasoline and benzine has increased enormously during the last few years and this is in coincidence with the boom in the automobile industry. It was assumed erroneously that this extended use was merely due to this fact.

Especially during the last ten years petroleum and its by-products gasoline and benzine have been used extensively for lighting purposes either in a crude way by burning it in liquid form or by turning it into gas by applying heat to a specially constructed carburetor which usually is applied to each lamp.

Another manner of using benzine for producing gas was in the introduction of gas machines which made gas by compressing air the latter being forced over big areas of benzine or gasoline until it saturates with the vapor of the benzine and forms in this way a burnable gas.

Just as simple as the production of the gas appeared just as difficult was it to get this fluid of an always uniform quality. This condition arose from the peculiar qualities of the benzine which is not a homogeneous chemical body but only a mixture of different components of the hydro class which according to their origin or place of destination are more or less volatile; therefore it is only natural that the air passing over the benzine first takes up the more evaporable parts and leaving the heavier of which the air only can absorb a little and therefore the carburization becomes imperfect. The gas thus becomes steadily poorer in benzine vapor and in calorific value and as soon as fresh benzine is added the amount of hydro vapor is suddenly increased in the gas which causes the burners to emit a smoke or very big flame.

For the technologist the task was to produce an air gas which per cubic foot contains an exact determinable and constant amount of hydrocarbon vapor and this quantity must be of such a low percentage that the gas even in winter could be used in extended pipe conduits without danger of condensation.

Let the gas be compared with the dew in the atmospheric air. It is well known for instance that air at 50 deg. F. can intake and embody more water steam (H_2O) than air of 200 deg. F. and if saturated air of 50 deg. F. is conducted into a room of only 20 deg. F. condensation occurs. It is very much like this with the air or gasoline gas. The tension of a liquid at a certain temperature allows figuring out how much vapor of the liquid a cubic foot or cubic meter of air can take up.

The benzine which is usually used for gas production has a specific gravity of 0.640-0.670 and its main components have at 32 deg. F. a tension of about 71 millimeters at 10 deg. F. 90 millimeters and at 50 deg. F. 115 millimeters but we get the percentage of volume the air is able to take up by applying the following formula

$$V = \frac{P \times 100}{700}$$

wherein P means the tension of the liquid to be gasified at a certain or given temperature. Hence for instance at 32 deg. F. the air is able to take up 137 grains of benzine vapor per cubic foot; therefor the gas of such a composition could be used at a temperature down to 32 deg. F. but would condense below this point.

By embodying 107 grains of vapor in a cubic foot of air gas is produced which remains constant at a temperature of 20 deg. F. and this composition is usually satisfactory to suit the average atmospheric conditions for the simple reason that an extended pipe system (town piping for instance) always must be placed below the frost line and as a rule moving gas never will assimilate the temperature of its environments or will be much affected by the temperature.

It is understood that the amount of benzine to be mixed with the air could be reduced further but it is not advisable to do so, as with this decrease of benzine vapor, the calorific value of the gas would decrease. The gas of the above consistency contains about 7.7 pentane, 72.9 nitrogen 19.4 oxygen and develops about 340 B. T. U. per cubic foot to which 18 to 20 per cent in efficiency should be added for the reason that the small amount of H_2O the gas develops when burned, increases the intensity of the flame.

The specific gravity of the gas is 1.12 and the table below taken from the report of a highly recognized authority gives a comparison between different kinds of light showing the air required to get a perfect combustion and the products derived from it.

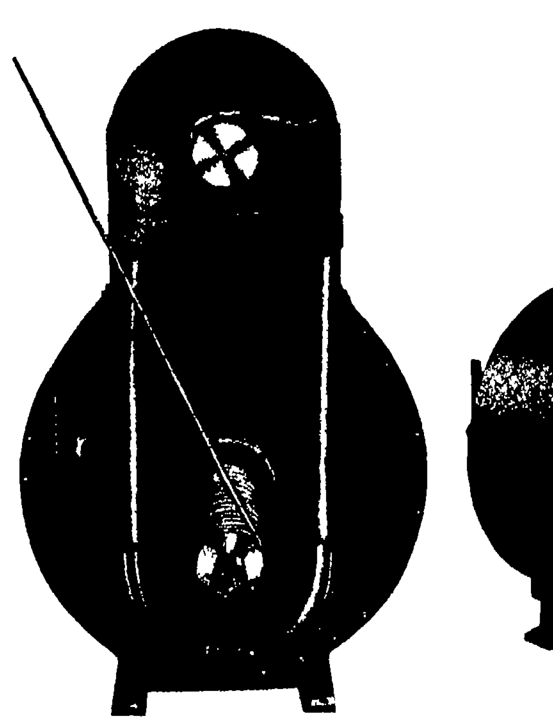
	Quantity liters	Candle power	Air required liters	Products of combustion CO_2	H_2O	N
Standard gas	100	58	211	38	46	246
Coal gas	100	40	625	50	1 0	500
Acetylene	30	40	3..	6.	30	300
Petroleum	1/5	50	2 125	272	337	1 700

Note.—28¾ liters are equal to 1 cubic foot.

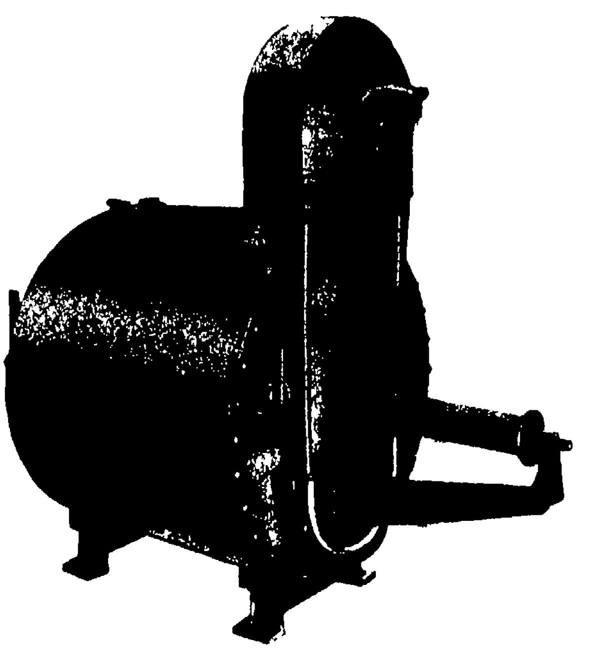
The principal idea of the gas machine shown in the accompanying illustrations and its process of making gas consists in: To drop exact measured quantities of gasoline or benzine into a rarefaction room (carburetor) where it evaporates and after this to mix the same with exact measured quantities of atmospheric air and to bring both together under a certain pressure which is necessary to conduct the gas to the burner, etc.

of the latter and the temperature conditions. The oil is fed into the carburetor in the following manner.

The turning of the sprocket wheel connected with the windlass operates the small upper sprocket wheel by means of the endless sprocket chain. As this latter sprocket wheel has but nine teeth it makes six revolutions while the windless makes one. To the axis of the sprocket wheel is fastened an eccentric which is grooved and into this groove an arm or pawl is adjustably fixed by a set screw. This pawl or arm reaches over and engages with its point a ratchet with about 1?0 teeth. This ratchet operates and controls the interior sprocket wheel which carries an endless chain of buckets. These buckets each contain an exact graduated quantity of oil and therefore bring a uniform quantity of fuel up from the bottom of the reservoir or return bent as the case may be. One complete turn of the ratchet wheel and consequently of the bucket sprocket wheel would empty a certain number of buckets. By sliding the pawl in one can regulate the number of teeth it will reach out and take. This is a valuable point to bear in



SIDE VIEW OF MACHINE FOR AUTOMATIC PRODUCTION OF A CONSTANTLY UNIFORM GAS



FRONT VIEW OF THE GAS MACHINE

This process is contrary to the previous methods of making gas which allow the air to take up as much vapor as the conditions of the liquid air and accompanying circumstances permit so that by a change of these conditions the quality of the gas is bound to change while the new vacuum process treated in this article takes care that the amount of the gasoline or benzine vapor never differs from the determined quantities.

This vacuum process further permits the use of the heavier and cheaper products of gasoline distillation—deodorized gasoline common motor gasoline etc. which cannot be used in any other gas machine.

In appearance the machine differs from those of other systems inasmuch that the carburization and the pressure process usually and for convenience take place at one time in the machine itself while in the other systems evaporization and pressure are two different operations.

It might be added however that the construction of the machine allows of transferring the twin operations to the outside of the building (outside carburetor) should conditions require it.

After the machine is wound up the sprocket wheel of 54 teeth attached to the outer circumference of the casing inclosing the planetary gears revolves with the inside drum. One revolution of the windlass unwinds about 10 inches of cable and causes one revolution of the inside drum making about 5 to 6 cubic feet of gas. To impregnate 1 cubic foot of air requires but a few grains of gasoline according to the quality

mind for if the gasoline is rich a smaller amount of gasoline must be fed and the pawl set accordingly to take less gasoline whereas if the deodorized gasoline is used as will ordinarily be the case the pawl must be set out further all of which can be best determined only after each machine has been installed and the quality of the gas has been determined.

In turning the smaller sprocket wheel the grooved eccentric turns and operates the pawl so that it reaches out and takes hold of as many teeth in the ratchet wheel as it may be set for. Therefore if the pawl is not engaged with the ratchet wheel it will not turn the same and will cause no feed of gasoline and consequently neither gas nor light is given out.

If we find by practical use of each installation that there is a sufficiently rich gas when the pawl reaches out and takes 14 teeth it will be seen that one revolution of the windless and consequently of the drum makes the sprocket wheel revolve 6 times and reach over therefore through the medium of the pawl and the take 6x14 teeth or 84 in all are engaged in one revolution of the drum which would figure down to 84/132 turn of the ratchet controlling buckets sprocket wheel or 14 buckets containing about 500 grains of gasoline for 5 cubic feet of gas. It will further be seen that from 1 to 22 teeth can be engaged by the pawl and here lies solely the regulation of gasoline feed. If your gas is too rich you can set for less teeth also if not rich enough for more but this regulation will be done but once and then the gas will be forever uniform provided always that the same quality of gasoline is used.

Moving Houses in Germany

An American Idea Transplanted

By A. F. Bock

THE moving of solid brick houses from one place to another is no longer an unshared privilege to America since recently this has been successfully effected in Germany at premises Nos 8 and 9 Seestrasse in South Berlin on each of which stood a two-storied solid brick house Not proving profitable the owner of the structure on the advice of Mr Richard Stephan a resident architect, decided to move one of the villas standing somewhat in the back ground to a place just behind the other When this was completed the ground at No 9 was free to be sold for building purposes

After the concession for this scheme had been granted by the authorities the work began First of all the walls of the house to be moved were wedged in slowly and by piecemeal immediately above the foundations and in the open spaces broad flanged Differdinger beams N P 24 were cautiously inserted For each wall two of these beams were used Then timber beams of 21x24 inch diameter the surface of which was mounted with 10 millimeter (0 394 inch) sheet iron two for each wall were placed horizontally on the foundations which before had been carefully leveled

Between timbers and beams a number of very strong

JACKS AND THRUST BLOCKS WITH WHICH THE HOUSE WAS MOVED

VIEW SHOWING THE FOUR TRACKS LAID ON CONCRETE FOUNDATIONS

MOVING HOUSES IN GERMANY

steel rollers were placed in spaces of 80 centimeters (31 5 inches) This work took a fortnight With the leveling of the foundations and when the masonry covering of the beams had well set the last remaining struts could be removed so that the house with all its weight of 400 000 kilogrammes (881 840 pounds) rested entirely on the steel rollers and could be easily pushed along

In the meantime for all the distance the house had to pass concrete foundations had been built which were rendered absolutely level and were covered with beams and iron plates in such a way that there were four tracks on which the house could be rolled along as represented in the illustration These preliminaries accomplished the proper work of moving the house could begin For this purpose a thrust block was fastened to the sliding beams (runners) and between these latter and the house three jacks were placed which had a pushing capacity of 15 000 kilogrammes (33 079 pounds) and a 40-centimeter (15 7 inch) stroke and were operated by three men at the same time This being effected the house could be moved as far as the stroke of the jacks permitted viz 40 centimeters (15 7 inches) After this the jacks were screwed back and between the thrust block and the former the operators inserted beams of the required length as shown in the illustration of the moving jacks and thrust blocks Now the moving could be repeated in the same manner as before always pushing 40 centimeters (15 7 inches) To secure the house against breakage while moving all windows were braced and strutted The inhabitants of the dwelling had all left, but a good deal of furniture still remained

The owner of the property intends to connect the two houses with a veranda after the moving has been completed and the villas stand one behind the other

The cost of moving repairs and reconstruction is considered to be nearly half as much as taking down and rebuilding the house

Tennessee's Resources Told in Pictures

IN this day and age when people write in shorthand they more and more want to read in pictures unless the matter is one in which they have already become interested Taking this view of the case the State Geological Survey has supplemented the bulletins it has been issuing which are intended primarily to give information when information is wanted or requested by a little bulletin describing very briefly the resources of the State but telling the story largely through photographs This is intended to interest the man who is now not interested but who may become interested and through that interest may ultimately move to Tennessee or invest in Tennessee Nor is this report intended alone for the people outside of the State Very few Tennesseeans realize the advantages the wealth the development or the future possibilities of their own State If they did there would be more boosting for Tennessee there would be less moving to Oklahoma there would be less need for the back home movement there would be fewer Tennessee capitalists looking to Texas or New York or other places for investment

The new bulletin is quite comprehensive in its scope describing not only the various mineral resources but also the soils the forests the topography climate transportation facilities etc even citing the State's wealth its debt tax rate etc It not only says that Tennessee is a pleasant place to live but it shows by selected pictures from the several sections of the State that it is It not only says the cities are progressive and busy but it shows by pictures buildings, homes parks, business sections wharves etc that the cities are busy up-to-date and attractive Attractive pictures of good roads and other country scenes show some of the phases of country life The forest resources are illustrated by cuts taken from the flank of the Great Smokies to the bottoms of the Mississippi Tennessee happens to have a number of industrial plants that are the largest of their kind south of the Ohio River Several of these are pictured in illustrating those industries. Pictures are also given of chert, limestone and marble quarries of coal iron and other mines, and iron foundries copper smelters, etc

On the whole, one can hardly look through the bulletin even though he does not have time to read it, without gaining the general idea that Tennessee is a pleasant land beautiful in its physiographic aspect, a good place to live, rich in many kinds of resources, and that those resources are being developed on a more or less large scale In addition to showing what already exists there, or is being done, the bulletin especially calls attention to opportunities for further expansion or for further development, either in agricultural development or in exploiting the State's wealth of minerals. It states that many of the mineral resources have hardly yet been scratched, and only awaiting capital to become the source of much profit. It calls attention to the fact that the opening of the Panama Canal is going to prove a gateway to the west coast of both North and South America, and to all of the Orient, and that in the new tide of commerce, which will take advantage of that gate, the South from its geographic position, has a great advantage over its more northern neighbors As Tennessee is probably the richest state of the South both in its mineral and non mineral resources, Tennessee ought to see a phenomenal growth during the next ten years But it is first going to be necessary that the people of Tennessee as well as those outside, realise the opportunities awaiting investment and labor and take advantage of those opportunities.

While the Geological Survey work will consist primarily in obtaining accurate information about the various resources of the State and then in supplying that information to those who may request it it believes that it is also part of its work to call attention to those resources in a way that would interest both people and capital, whether they are now interested or not

The bulletin has been attractively printed on calendered paper and reflects credit upon the printer, Brandon Printing Company of Nashville It can be obtained by applying to the State Geologist, Capitol Annex, Nashville or upon request accompanied by 2 cents in postage from those outside of Nashville.

New Standard Gage Electric Railroad

THE new standard gage railroad which will be opened in Sweden in 1914 presents a considerable interest. It belongs to the State railroad lines, and as we have elsewhere mentioned, runs from the mining district of Kiruna to the frontier Recently the contract was awarded for part of the electric locomotives to the German Siemens-Schuckert firm, and these are now building at the Berlin works. However, a Swedish company is constructing two high-speed passenger locomotives and two freight locomotives, while eleven freight locomotives will be built in Germany These last are of the double type and consist of two separate units coupled together Each unit or half-locomotive has three bar-coupled axles operated from a single electric motor Transformers on the locomotives are used for lowering the voltage. As each half of the locomotive is independent, this gives a good means of guarding against accidents. The motor is mounted inside the locomotive cabin and drives the wheels by crank drive, so that a large sized motor can be used and there is given better air cooling. The Porjus Falls will be called upon to furnish the current for the electric railroad, and at present the construction work upon the hydraulic plant is being carried out.

Giant Gas Engines and Blowing Tubs

TWELVE CAR TRAIN LOADED WITH A SINGLE BLOWING UNIT

THE beginning of the twentieth century has seen many advances in the methods and machinery employed in the manufacture of steel. One of the most notable changes has been the introduction of the large gas engine designed to operate on the waste gases from blast furnaces and used to drive the electrical generators which furnish power for driving the machinery about the plant. Another application to which the gas engine has been put is to drive the air compressors which furnish the blast to the furnaces. At the same time a new machine has been introduced to take the place of the older steam driven blowing engine. This is the Slick blowing tub. The first large installation of this type of blowing units was erected at the Homestead Works of the Carnegie Steel Company, where the makers, Allis-Chalmers Company, installed four 42-inch × 54-inch twin tandem gas engines driving 72-inch Slick tubs. When the big power house of the Indiana Steel Company at Gary was built, eight of these units were installed in that. Since then similar units have been installed in the South Chicago plant of the Illinois Steel Company, in the Algoma plant of the Lake Superior Iron and Steel Company, and others larger than any yet installed are now building for the central furnaces of the American Steel and Wire Company at Cleveland.

The design of the Slick tub makes possible the delivery of a much larger quantity of air from a smaller piece of apparatus than was possible with the older type of blowing engine. Two Slick tubs are all that are necessary for the largest furnace, while three or four of other types would be necessary.

The essential difference between the Slick blowing engine or tub, as it is commonly called, and other blowing engines lies in the method of admitting air to the compressing cylinder. In other types large valve area is required, which necessitates either large valves or numerous small valves. In the Slick design the entire cylinder of the compressor serves as the valve. The inlet ports in this design are located in the barrel of the tub and consist of a series of circular openings extending entirely around the circumference of the barrel at each end. The barrel is not attached to the heads but is supported and moves on independent slides at each side. Connection is made to the engine on each side and the barrel is given a reciprocating motion while the heads remain stationary. This construction gives great inlet area for a very small motion of the barrel and leaves the entire area of the heads free for the discharge valves.

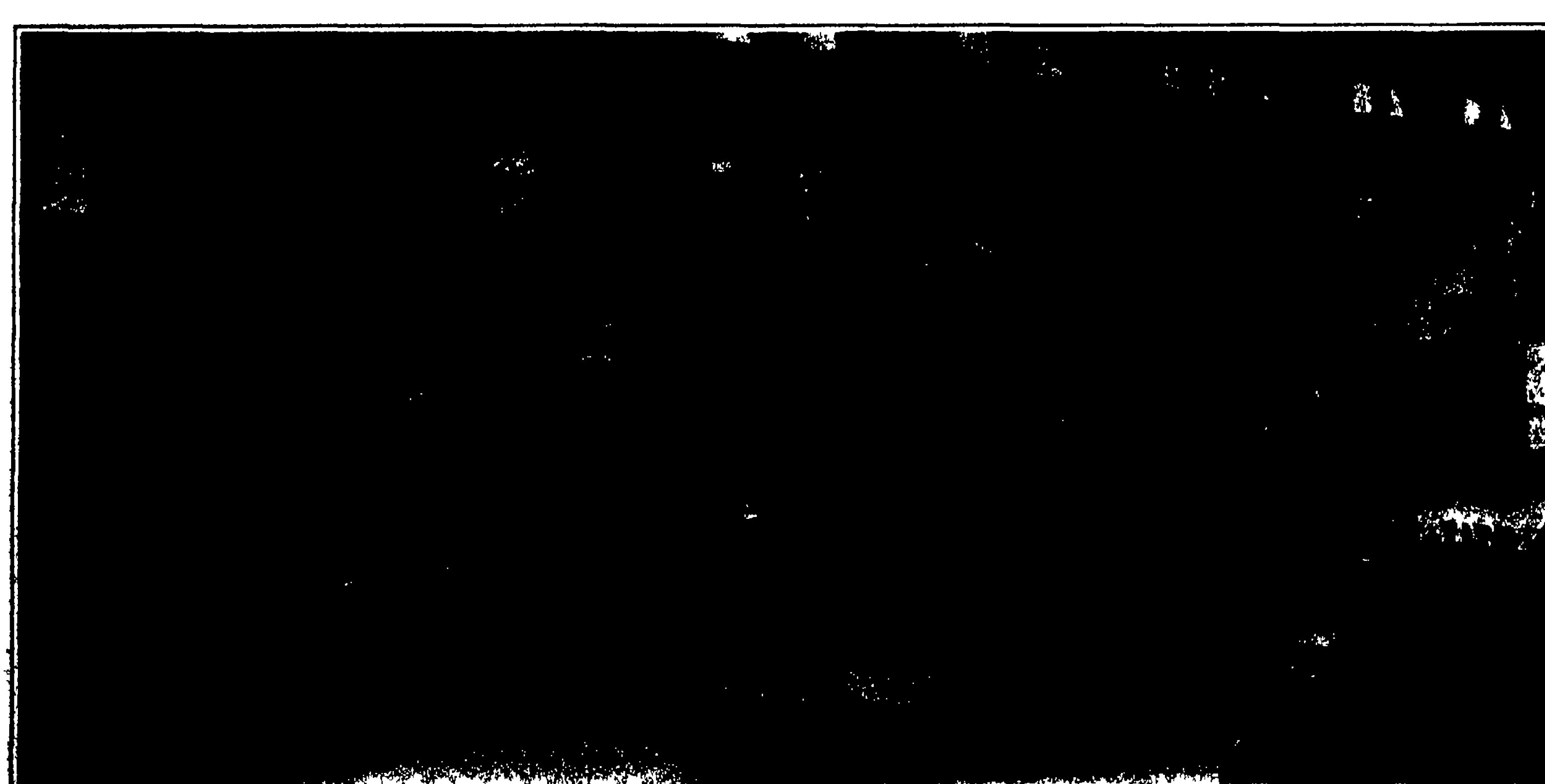
The advantage of this construction is that the air completely fills the tube with practically no drop below the atmospheric pressure at the beginning of the suction stroke. The large discharge valve area of the heads greatly reduces the clearance necessary in the cylinder and also prevents the air pressure in the cylinder rising much above the pressure in the receiver. The small movement of the valves and the large port openings permit of much higher piston speeds than can be used with other types of blowing engines and consequently the use of smaller machines for the same amount of air.

These Slick blowing tubs are used with both steam engines and gas engines, more frequently with the latter, however, as they were developed about the same time that the large gas engine came into use in the steel industry. The usual practice is to place the steam or gas cylinder at one end of the frame while the tub is fastened to the other. This gives a short and direct drive for the barrel from the engine shaft, while the air piston is connected to the cross head by means of distance rods and has the same travel as the gas piston. This gives a very rigid and compact machine.

The gas engine which Allis-Chalmers Company build to go with these blowing tubs embodies the most modern developments which experience has proved advisible, with the result that its design differs somewhat from European models in order to meet American conditions. Progress in the design of large gas engines has been much influenced by natural conditions existing in the steel industry, which presented an ideal field for their use in the utilization of waste gases. The conditions demanded an engine which would operate on a gas of low heat value and which was reliable for continuous and severe service.

The Allis-Chalmers gas engine is of the horizontal double acting four-stroke-cycle type, with the gas cylinders arranged in tandem. This arrangement applies power to the common piston rod at each forward and backward stroke and gives the same continuous application of power to the crank shaft that is obtained with the simple steam engine. When twin engines are used, as with the blowing tubs, four power strokes are obtained per revolution. These, with the use of a properly designed fly wheel, give a very even turning moment.

It is in the frame that the principal difference in design is apparent. Foreign practice favors the use of the center crank, which necessitates three bearings for a single engine and four bearings for a twin engine. The Allis-Chalmers engine requires but two bearings for either single or twin engine. Another essential feature of this engine is the use of an intermediate cross head between the two cylinders and a tail cross head behind the second cylinder. These support the pistons and piston rods so that they can travel without touching either the bore of the gas cylinders or stuffing boxes. This design also places the inlet valves at the top of the cylinders and the exhaust valves at the bottom, which is essential to the proper scavenging of the cylinder. Provision is also made for removing the cylinder heads without disconnecting the cylinders from the main frame or tie pieces. These gas engines give the impression of solidity and simplicity and show great strength. Their quiet running and freedom from vibration are



THE ALLIS-CHALMERS TWIN TANDEM FOUR-CYCLE GAS ENGINE

GIANT GAS ENGINES AND BLOWING TUBS

particularly apparent This is true with overloads as well as underloads and there is in fact no noticeable change in the operation under wide variation in loads

As the point of greatest stress in a gas engine is in the frame the weight of the frame of this engine is made about one fourth the total weight The jaw in which the main bearing shells are held and which is subject to the greatest stresses is made particularly heavy and rigid It is further strengthened by two steel tie bolts extending across the jaw above the shaft which eliminate all bending stresses in the frame at this point but do not interfere with the removal of the main bearing cap

The cylinders are cast in one piece and a tough fibrous iron is used which is well adapted to meet the strains encountered The outer cylinder walls with the tie pl e form a continuous frame work and provide a very rigid construction The inner wall of the cylinder is subjected to the explosive pressure only Gas and air inlet passages and a distribution chamber are cast integral with the cylinder

To provide a wearing surface the cylinder is fitted with a liner of a special grade of very hard fine grained iron which has particularly good wearing qualities and which readily takes a high polish and thereby reduces friction A special patented construction of a tongue and groove fit at the middle of its length together with a shrink fit over its entire length holds the liner firmly in place while permitting free expansion with the cylinder walls

The valve gear is of the stratification type which permits control of the engine by varying the relative proportion of air and gas The valve is double seated with the air admission between the two seats and the gas admission above the upper The relative amounts of air and gas are controlled by an auxiliary lay shaft actuated by the governor The two inlet valves for each cylinder are located at the top and the two exhaust valves at the bottom so that all impurities leave the cylinder in the most natural way The exhaust valves and all the parts of the engine coming in contact with the hot gases of explosion are water cooled

These engines are started by means of compressed air and an auxiliary starting gear which is automatically cut out when the engine is ready to operate on gas The method of starting is very simple and the time occupied is inappreciable In one of the large power houses where these engines are used to drive alternators it is usually less than one minute from the time an order is given to start the engine to the time it is put in service and delivering load The record time is 37 seconds

One of the accompanying photographs shows a train loaded with a single Allis-Chalmers gas engine blowing unit The apparatus loaded on the train contains the parts of a twin tandem gas engine and the Slick blowing tubs for the unit The first two cars are loaded with the main engine frames weighing approximately 180 000 pounds each the third car supports the main shaft and cranks the next four cars each carry a gas engine cylinder the next two each hold a tie piece and tail piece for one gas engine while each of the last two cars is loaded with a Slick cylinder and some of the accessory apparatus Many of the detail parts are not shown in this photo

During the past few months the Allis Chalmers Company has shipped four gas engine generating sets and two gas engine blowing units to the Lake Superior Iron and Steel Corporation at Sault Ste Marie, Canada, and has two more of the blowing units nearing completion Each one of these units requires twelve cars for its transportation and its weight is approximated 1,000,000 pounds.

These gas engine units are being installed in a large extension of the Lake Superior Iron and Steel Corporations plant at Sault Ste Marie Ontario Canada The original rail mill will have a largely increased capacity and new plate and merchant mills will be built as well as coke ovens Operations will be started at the plant in the near future For furnishing power for the mills and blowing the furnaces the company purchased the above units from Allis Chalmers Company They will be supplied with gas from the blast furnaces.

The gas engines are all alike being of the twin tandem four-cycle type with cyclinder 34 × 48 inches. They conform to the company's standard in all respects Four of these engines are direct connected to 1 765 K V A 25 cycle 3 phase 2,300-volt alternators running at 107 R P M These sets will supply power for driving the motors about the mill

The other four units are to be connected to the new Slick blowing tubs manufactured by Allis-Chalmers Company These tubs are 64 × 48 inches and are arranged to operate duplex on the opposite side of the main shaft from the engine Each blowing unit has a capacity of 25 000 cubic feet per minute when running at 72 R P M but can be speeded up to 85 R P M if necessary

When the new works are completed this will be the largest steel producing plant in Canada and naturally the most modern Mr Alfred Ernst has been consulting engineer on the work and much of its success will be due to his efforts

Heating and Ventilating the Yarrow Home

A Series of Interesting Experiments

The question of providing the best system of ventilation and heating for public buildings and especially for Hospitals and Convalescent Homes is of so much importance that the following experiments cannot fail to be of interest

On the occasion of the annual gathering at the Yarrow Home on July 17th 1909 certain changes which had recently been made in the heating and ventilation of the Institution were described by Mr Yarrow

The system of heating and ventilation was carried out in a very complete manner when the Home was constructed and was based upon the best knowledge available at the time but experience has indicated that in many essential particulars the system adopted was far from satisfactory and it became evident that changes must be made

The heating was secured by means of numerous radiators in the usual manner fresh air from outside being admitted through openings at the back of the radiators thus coming in direct contact with the hot surfaces and getting warmed on its passage into the building This at first sight appears correct but a little consideration shows it is open to objections What really happens is that the radiators very soon get covered with dust brought by the incoming air and this dust as is well known brings with it numerous microbes Often these radiators are fixed in such a position that it is impossible to clean them efficiently Sometimes they are in recesses to be out of the way at other times the design of the radiators is such that it is impossible to get brushes between the heating tubes On some systems the heating is done by means of hot pipes under the floor with gratings above them and on others the radiators are enclosed in ornamental cases for the sake of appearance In most cases it is found that the radiators are of such a design or so placed that it is impossible to secure the cleanliness and freedom from deposit of dust so essential to good sanitary conditions

Mr Yarrow pointed out that the conviction was forced upon everyone who had studied the subject that the only form of really good radiator is one of such design and so placed that it can be cleaned and dusted daily with facility Probably to carry this out in the best manner the radiators should consist of polished tubes because being bright any deposit of dust is made visible and in addition servants naturally if they take a pride in their work see that any polished surface is kept in a creditable condition

Having these considerations in view the inlets which previously conducted the fresh air into direct contact with the radiators were permanently closed so that now the air has not the opportunity of depositing its dust upon the heated surface of the radiators or of carrying into the rooms the already accumulated microbes

Mr Yarrow then described the system of ventilation originally adopted which consisted of horizontal air ducts along the ceilings of the rooms These air ducts terminated at each end of the building in tall ventilating shafts The tendency for the hot air to pass out in this way is due to the difference in weight of the hot air inside the shaft and the cold air outside the building just in the same way that a chimney over a fire allows the hot products of combustion to pass upwards In such ventilating systems however the difference of temperature and consequent weight of the air is so very small that the draught is necessarily sluggish consequently to reverse the direction of the current of air requires very little counteracting influence

Mr John Sampson a member of the Committee of Management of the Home drew attention to the effect which wind had on ventilation and demonstrated in the clearest possible way that wind striking the building on one side had a tendency to increase the pressure of air in the rooms on that side and at the same time to diminish the air pressure in the rooms on the opposite side Now in those rooms where the pressure was diminished the reduced pressure had clearly a tendency to upset the system of ventilation causing the passages which were intended as upcasts to be downcasts

Numerous experiments were tried in all the rooms not only when there was no wind but when the wind blew on the building from different quarters It was found that when there was no wind the ventilation acted perfectly and as was intended but the moment a slight wind arose which at Broadstairs is of general occurrence it was found that in many of the rooms the air instead of passing away through the ventilating passages and up the shafts was actually drawn down owing to the suction due to the reduced air pressure in those rooms on the sides of the building opposite to those upon which the wind blew Now it is self evident that if the air enters the building after having passed through passages which from their nature can never be cleaned and which are charged largely with dust full of objectionable organisms and which were never intended for admitting air but for letting it out the result must be most unsatisfactory and there appeared to be a reasonable probability that many sore throats had been due to this cause

The committee being firmly convinced from the above considerations that the system of ventilation had been founded on wrong principles ordered all the openings in the ceilings of the rooms leading to the ventilating passages to be closed They had the beds removed from the sides of the dormitories and placed in the center and gave instructions for the windows to be always slightly open so that the ventilation of each dormitory should depend entirely upon the passage of air across the rooms entering the side where the wind blew and finding exit on the opposite side As there scarcely ever exists a time when there is not more or less breeze, it would appear that this was both a simple and efficient means of continually changing the air

As the result of this investigation it would appear that one of the secrets of ventilation is to prevent air passing through any passages where dust and dirt can accumulate In fact the air prior to entering the rooms should pass over the minimum surface

A doll's house was used in order to illustrate by actual experiment what occurred when a current of air blew on one side of the home A fire was lighted in a room in the doll's house and the smoke ascended and was seen issuing from the chimney A rotary fan actuated by an electric motor produced a current of air corresponding to a moderate wind—that is to say from 12 to 15 miles and hour—which was allowed to impinge on one side of the doll's house and it was at once seen when the window was open in the doll's house on the side opposite to that on which the air impinged that smoke was immediately drawn down the chimney instead of passing upwards owing to the reduction of pressure on the side opposite to that on which the current of air was blown

The following description was given by Dr Dawson

The bacteriological examination of the air not only confirmed the opinion that under certain conditions what are intended for ventilating outlets became inlets but also showed the vitiation of the air in Ward No 1 which resulted

Two prepared plates were exposed beneath the air shaft in the ceiling of the ward These plates were so to speak back to back that is the medium on the one looked upward toward the opening in the ceiling and the medium on the other looked downward toward the floor Plates were exposed actually within the air shafts Others were also placed on the beds in the ward and finally a plate was placed midway between the floor and ceiling underneath the air shaft All these plates were exposed for a period of five minutes The results were as follows

The plates within the air shaft, and the plate immediately beneath it showed a rich growth of microorganisms whereas the plate under the air shaft whose medium looked downward was comparatively free The plates also placed upon the beds in the ward contained only a few colonies.

Further than this among the rich crops of microorganisms found on the plates near the air shaft were many pathogenic varieties, and especially noticeable among these were the *Micrococcus Catarrhalis* and *Staphylococci* which are so often associated with sore throats whereas in the plates remote from the air shaft the pathogenic organisms were *exceedingly* few The fact that the plate near the air shaft which looked upward was richly covered with organisms—whereas the plate immediately beneath it which looked downward showed very few—shows that the air was traveling *into* the room and not *out* of the room through the so-called outlet This conclusion was further confirmed by the plates inside the shaft con

...the same varieties of organisms as the plate immediately beneath the grating

In Ward No 2 very similar in size and shape a control experiment was conducted the air shaft in the ceiling being blocked up, and plates being exposed in the same position as in Ward No 1 The plates in every instance showed but a feeble growth of micro-organisms, one of the plates showing only 17 colonies as against 89 colonies found on the similar plate correspondingly situated in Ward No 1 It is clear, therefore that the air was a great deal purer when the ventilating outlet in the ceiling was blocked up

Now the Yarrow Home has been troubled for some time past with small epidemics of sore throats and it has been in some instances established that the sore throats do not spread from person to person but would break out in different wards where the inmates have not been in contact

These troubles entirely ceased when the ventilating shafts in the ceilings were closed The fact is that the ventilating shafts which lead from the ceilings of the wards to the outer air are in close juxtaposition. As long as there is no wind it is probable that these shafts would operate as outlets as they were originally intended to do but directly there is a wind these outlets become inlets and impure air enters the wards and the air of one ward can communicate with the other

This investigation also shows once more that all air shafts are dangerous unless they are so big and so situated that they can be easily and regularly flushed with water Unless this is the case the air shafts collect more and more dust and the air which passes along them becomes increasingly dust laden and therefore microbe laden The wards have been far more healthy at the Yarrow Home since these air shafts were blocked up and the windows and chimneys have been relied upon for ventilation

The examination of the air was made at the suggestion and under the supervision of Dr Dawson assisted by Dr Moon The bacteriological experiments were carried out by Dr Adler

On November 1st six months after the above changes in the heating and ventilation had been made Miss Chambers the lady superintendent of the home reported as follows

We have found a very appreciable reduction in the *number of sore throats during the past six months* and of the few cases we have had all have been children with adenoids and enlarged tonsils or who suffer from repeated sore throat affections at home We have had a case of measles and two of chicken pox during the last six months but no spread of infection from either as formerly experienced

The Bee as an Engineer

The Structure of a Piece of Honeycomb

By A H Godard

Honey bees have always been a subject of great interest for the naturalist and one of the most interesting features of their work is the home and store house which they build for themselves (Fig 1)

Nearly everybody has seen a piece of honey comb but probably few realize how perfect a piece of architecture it is for the purpose intended It is perfect because it combines these three qualities *it has no waste room it has the greatest possible strength and it is constructed out of the least possible material*

If we look at the face of a piece of comb we observe that the cells are six sided Did you ever stop to think why? The answer is because that is the only shape that will fulfill the above conditions Let us see In the first place there are only three forms of cells that can be placed side by side without leaving waste spaces between (see Figs 1 2 3 4 5) There are the triangle the square and the hexagon Secondly the more nearly round a hollow object is the more pressure will be required to crush it a fact well known to every one and thirdly the more round it is the less material will it take to complete its peripheral wall One might almost imagine that these last two facts are recognized by the bees themselves for in the case of a special cell that they construct for their queen where there is only a single cell built up on the edge this cell is always round and not hexagonal But to prove the third proposition the economy of material let us look at Fig 6 which represents four different forms with an area of uniformly 144 square inches The triangle will be about 18¼ inches on a side and 54¾ around The square will be 12 inches and 48 inches around The hexagon will be about 7½ inches on a side and 45 around while the circle which we have said we can not use would be only 42½ inches around So again we find the hexagon requiring less material than the other forms and thus fulfilling all three of the conditions named

So much for the sides Now let us look at the bottom of the cell Usually a piece of comb is about an inch in thickness but you will notice the cells only run half way through that there is a partition in the center which forms a bottom for the cells on both sides of the comb (see *A* Fig 7) Now these cells from opposite sides do not meet haphazard but if you will look into an empty cell (see dotted line cell Fig 8) you will notice that what is the center of the cell on one side coincides with the point where three cells come together on the opposite side Again the bottom of the cells are not flat like the bottom of a tumbler as represented by Fig 7 for in that case there would be the square corner and the same waste of material as in the square cell but each cell is carried out to a point past the center of the comb (Fig 9)

The question then arises how can this be done so as to have opposite cells match? This can best be understood by a simple illustration Cut off from a common six-sided lead pencil four pieces an inch or more long sharpen them exactly alike bluntly cutting only from the flat sides then tie three of them together to represent one side of the comb and try to fit the fourth piece and you will find that they will not match So we must try again Now sharpen your pencils once more, this time by cutting the corners instead of the flat side and be sure you cut only every other corner This will give you three surfaces instead of six Now tie together again and you will find a perfect fit (see Fig 10)

Now if you should look into a cell you would see three flat surfaces running to a point, as represented by the dotted line cell (Fig. 8)

But this is not all If this point were made too long or too short then again there would be waste of material as well as strength There must be a certain specific correct length Let us look once more

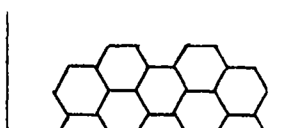


Fig 1

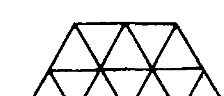


Fig 2

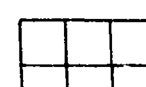


Fig 3

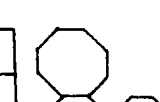


Fig 4

Fig 5

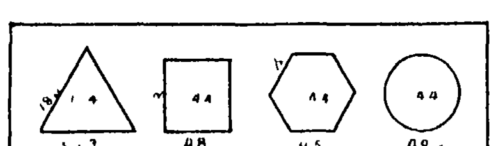


Fig 6

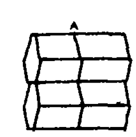


Fig 7

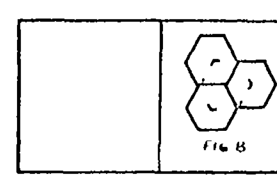


Fig 8

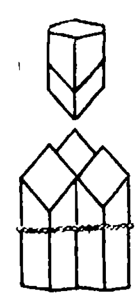


Fig 10

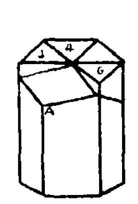


Fig 11

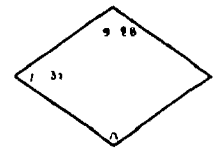
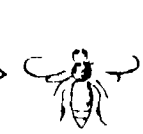


Fig 12



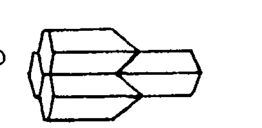


Fig 9

into the cell and we find the three end surfaces are *rhomb shaped like Fig 12 with two obtuse and two* acute angles (see obtuse angle at *A* Fig 11) and it is evident that as the point of the cell is moved in or out this and the other angles will change the farther the point the more nearly square the rhomb will become and of course the less the obtuse angle will be Many years ago a naturalist requested a celebrated mathematician to solve this problem What should be the angles of the facets of a three sided pyramid terminating a six sided prism so as to combine the greatest strength with the least material You will notice that this is the problem before us His answer was 109 degrees 26 minutes for the obtuse and 70 degrees 34 minutes for the acute—values falling within one-thirtieth of a degree of what the comb actually measures the exact measurement being 109 degrees 28 minutes and 70 degrees 32 minutes Notice how this piece of bridge work in the center of the comb stiffens and braces the structure

So far the material for the comb is supplied by the bees from their own bodies issuing from the over lapping joints or rings seen on any working bee But there is still one place of the comb that is a little weak namely *the mouth of the cell* This weakness is remedied by the use of a substance which the bees gather from the barks of trees and which has been called "propolis" a Greek word meaning "before the city" This material is of a much harder and firmer nature than the comb itself If you take a piece of white comb and tip it so that you can just glance across the surface you will discover the presence of the propolis by its brown color

The writer has seen strips of comb a foot wide and four feet long sustaining a weight of thirty or forty pounds of honey while the comb itself would probably not weight more than five or six ounces We need not hesitate to say that such a structure compares favorably with some of the best achievements of the modern engineering skill of man

A New Variety of Selenium

L C Brown has discovered a new variety of selenium in which the electric resistance is increased instead of being diminished by exposure to light Its specific conductivity is one million times greater than that of ordinary selenium Thirty experiments were required to produce five specimens of the new form of selenium which is very unstable during the process of formation In every case the selenium was crystallized in molds of enameled porcelain Two German silver wires about ⅛ inch apart served as electrodes The resistances of the five specimens each measured in the dark two hours after its removal from the crystallization oven heated to 28 deg F differed very greatly the values expressed in ohms being 13 12 117 161 and 187 The surface of the selenium was smooth and reddish gray at first but the tint afterwards became redder and darker The resistance of one specimen rose from 117 to 118 ohms in 10 seconds exposure to the light of a 16 candlepower carbon filament electric lamp at a distance of four inches The return to the initial resistance appears to take place as rapidly and completely as it does in ordinary selenium cells Several years ago Brown advanced the theory that ordinary selenium is a mixture of two or more allotropic forms He regards the new variety of selenium as a mixture of the same ingredients in different proportions

Diesel Marine Engines—II*

A Resume of Recent Performances

By Herr Th Saeuberlich of Osterholz-Scharmbach

Continued from Supplement No. 1846, page 318

The reversing gear of this engine differs from other known designs The principle employed is to move the valve shaft on which two separate sets of cams are fashioned endwise the valve levers being raised by cams just before this movement takes place and lowered again when it is complete These movements are effected in the following very simple way and by the use of a single hand wheel

The shaft *a* -Fig 8—passes over all the cylinder covers being carried by the columns *b* of which there are two in each cover To this shaft are keyed the fingers *c* one over each exhaust and suction valve and the lever *d* which is linked by *e* to the

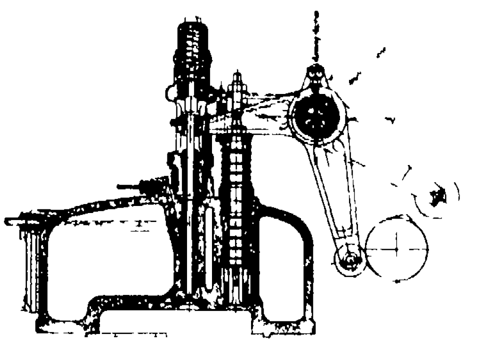


Fig 7 AIR AND OIL VALVES AND GEAR

curved lever *f f* in turn being coupled to the reversing cylinder which has pipe connection *g* and *h* coupled to the valve box beneath the hand wheel Here either valve can be released by movement of the ⊥ lever *l* which is effected by one end or other of the notched quadrant *n* coming into contact with it this quadrant being keyed to the hand wheel shaft The valve being opened further movement of the plate releases the lever and the valve again closes Owing to the form of the quadrant *n* and the notches in the quadrant *p* this movement can only be effected in the central position II In Fig 10 is seen a sector T which is provided with a cam face which moves the lever *B* and thus moves the reversing cam shaft V endways The sector is coupled by the link shown to the shaft *u* The action of the reversing gear will now be easily understood The hand wheel is moved to the middle position and is then revolved till the stop *r* on the notched quadrant comes against the quadrant *p* and stops further movement During this action the valve *i* would be opened for a short time allowing compressed air to get under the piston *k* forcing it up This causes movement of the linkage and presses the valves down into the cylinder When they have reached their lowest position the action of the cam *T* moves the cam shaft endways By that time the piston *k* has returned to its starting position lowering the valve rockers on to the second set of cams The glycerine dashpot acts as a brake to prevent reversal taking place too violently It must be added that during this process the rollers of the starting and fuel valves are lifted off their cams and do not interfere with the motion This is effected as seen in Fig 7 by mounting the respective rockers on eccentrics keyed to the shaft *w* By turning the sleeve the fuel valve lever moves away from its cam while the starting valve lever approaches its own cam In this position both levers are free and the shaft can be moved endways By further movement to the starting position the fuel valve lever leaves its cam contact with its own Rotation is given to the eccentric sleeve in the manner shown in Fig 9, from which it will be seen that it is coupled by the rod *L* to the shaft *M*, to which is also keyed the hand wheel bracket *H* This bracket with the hand wheel can be moved to three principal positions on the notched quadrant the first for running the second neutral, and the third or lowest for starting Further notches for high and slow speed are also provided This control is effected by the link *d* which acts upon the fuel pump regulator rod As the centrifugal governor shown also acts upon this rod an elastic coupling in the form of a flat spring *F* is provided The governor was originally provided for the test stand but in view of the fact that the engine might run light has been retained

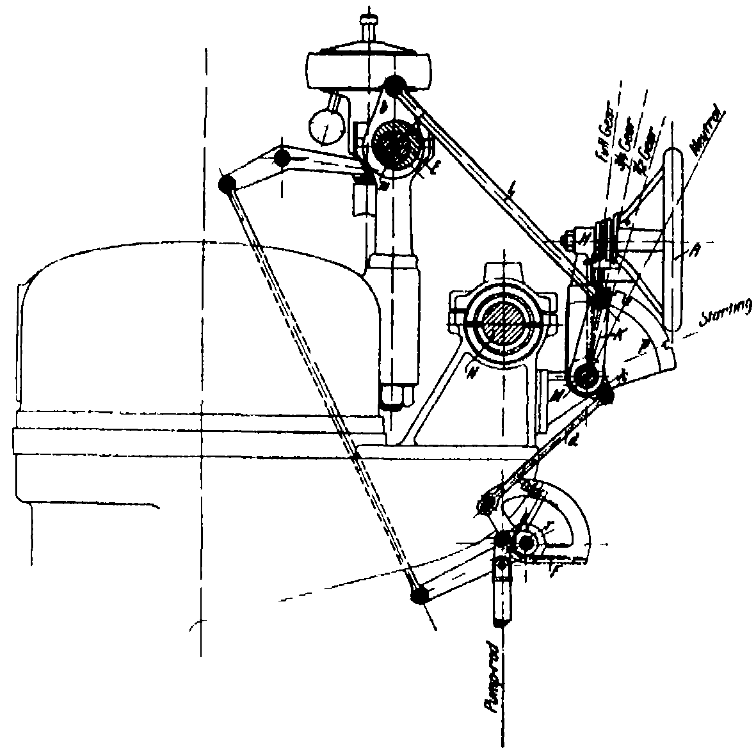


Fig 9—CAM LIFTING AND GOVERNING GEAR

It has already been pointed out that in a four-cycle engine all four cylinders might be in such a position as to render starting by compressed air in the cylinders impossible and that therefore arrangements had been made to use the air compressor for starting under such conditions This air pump is shown in section by Fig 11 It is a two-stage compressor with the low pressure stage double acting and without suction valves, air being admitted by the piston overrunning a central port On this low pressure cylinder are placed the starting valves *A* and *B* operated by the cams and links shown The compressor being double acting it is easy to arrange that it shall start in any position which it is not possible for the power cylinders to start from Diagrams from the compressor are given in Figs. 12 and 13, and enlarged views of the valves in Fig 18 The fuel pump is illustrated by Fig 17 There is one plunger to each main cylinder, but the plungers are coupled in pairs so that only two eccentrics are required. The governor already described acts, as shown in Fig. 17, upon the suction valves. The pump body is a single piece of wrought iron.

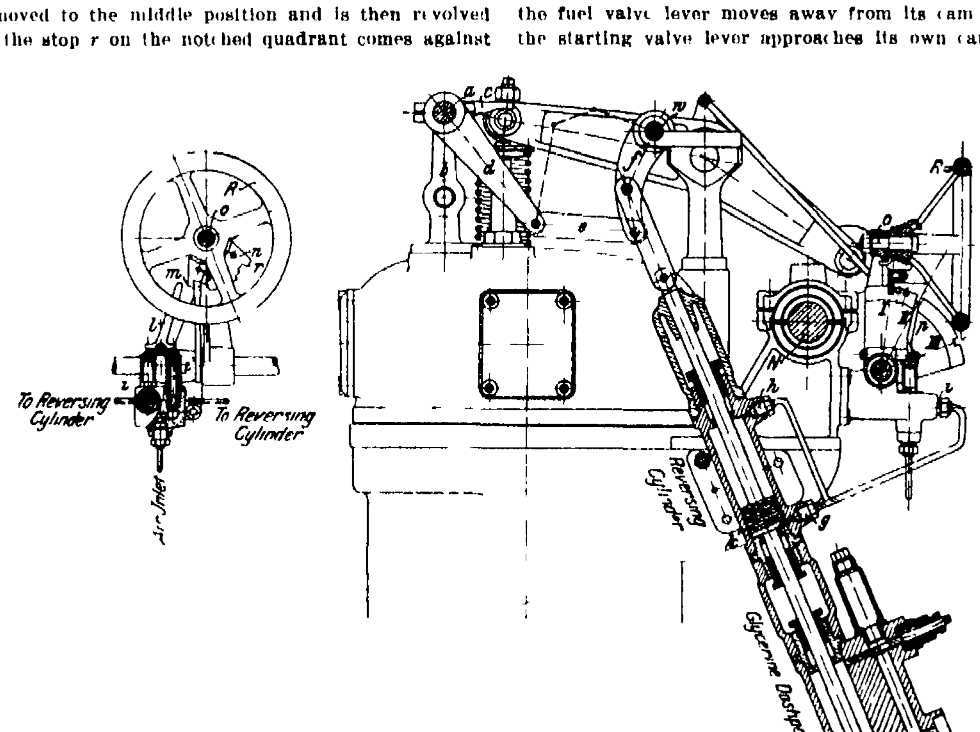


Fig 8—REVERSING GEAR

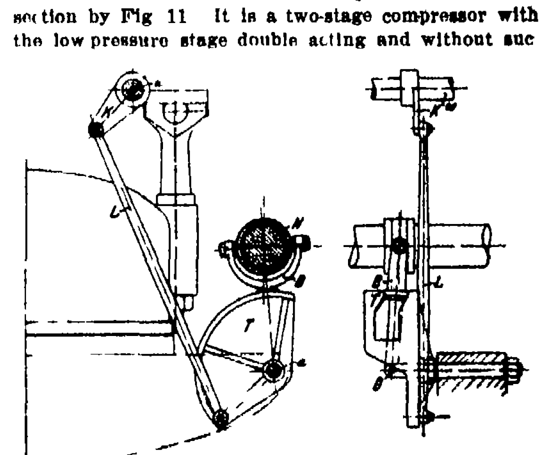


Fig 10—CAM SHAFT GEAR

* Abstract translation by *The Engineer* (London) from a paper read before the Schiffbautechnischen Gesellschaft and published in the *Journal* of the Society by Julius Springer Berlin.

method of constructing the valve cams is shown ig. 15 The exhaust and suction cams are of cast , and the starting cam of cast iron By this od a small diameter of cam results and quietness unning is secured.

e lubrication of the gudgeon pin which is always oublesome matter is effected in this engine by the ce shown in Fig 14 Here the tube *A* on the pis at each outward stroke is driven into oil contained in the cup shown some oil enters the tube and being retained by the little ball valve is driven up by the next descent of the tube

The method of driving the cam shaft is illustrated by Fig 16 It will be seen that the arrangement permits endways movement of the shaft, while the long bush acts also as a thrust block

It is not generally possible to obtain such good diagrams from high speed as from slow speed engines owing to the very short space of time in which explosion has to take place but almost ideal cards as shown in Fig 19 are obtained from this engine The average pressure shown by this diagram is about eight atmospheres The fuel consumption measured on the test bench amounted to between 215 and 220 grammes per effective horse power per hour

Practical Results The service boat in which the engine just described is fitted has been for a long

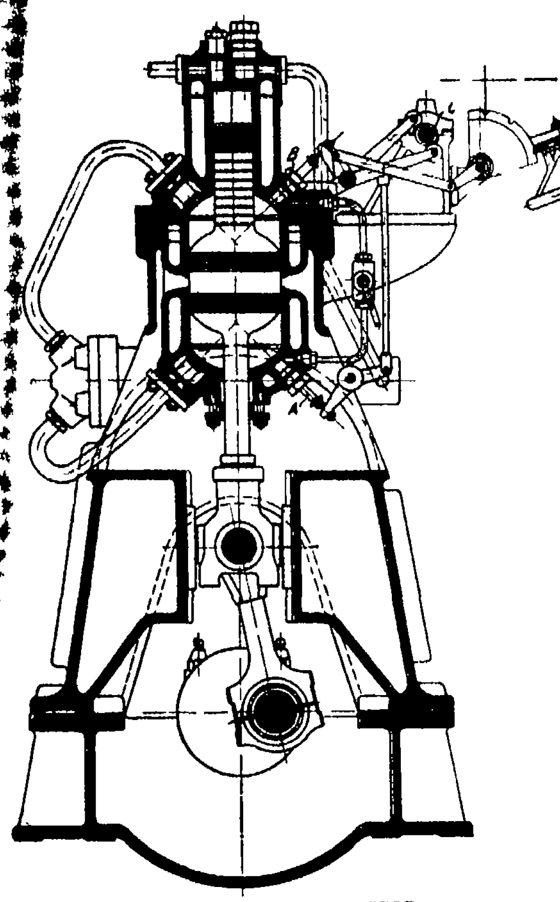
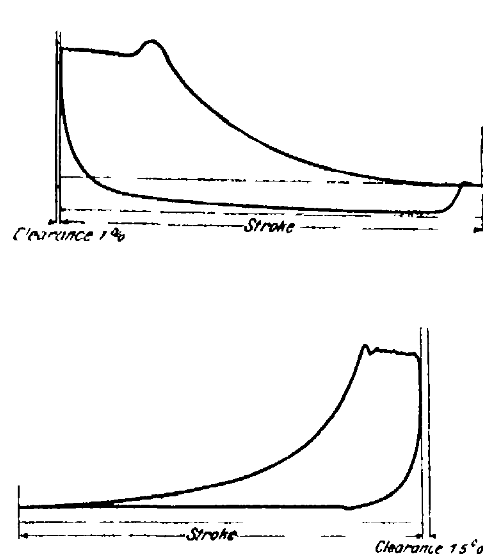


FIG 11 —AIR COMPRESSOR



FIGS 12 AND 13 COMPRESSOR CARDS

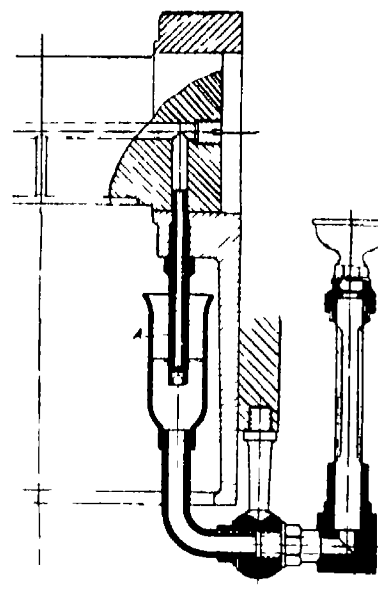


FIG 14 GUDGEON LUBRICATOR

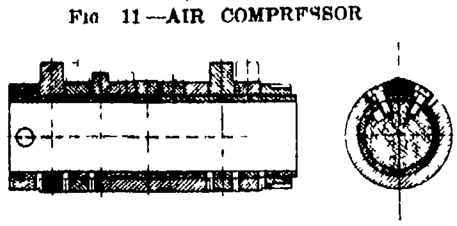


FIG 15 —VALVE CAM

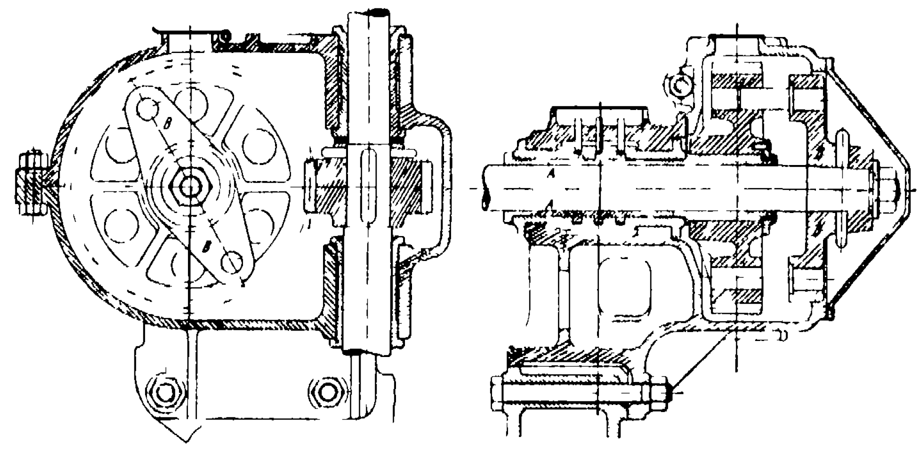


FIG 16 —CAM SHAFT DRIVING GEAR

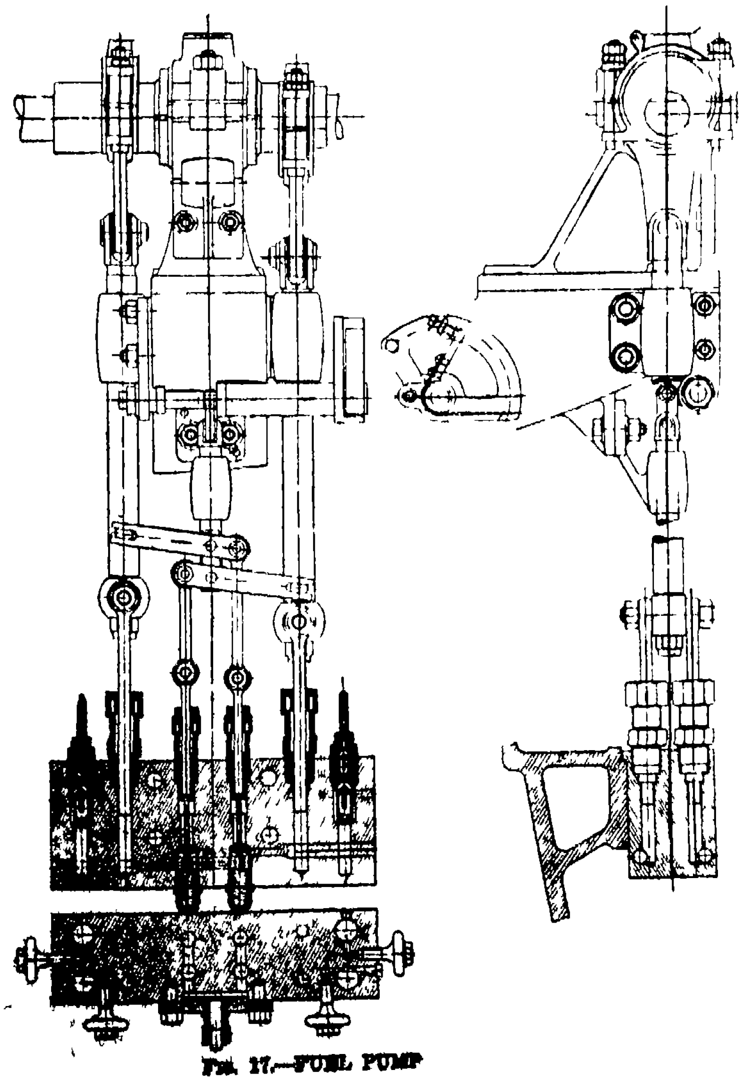


FIG. 17.—FUEL PUMP

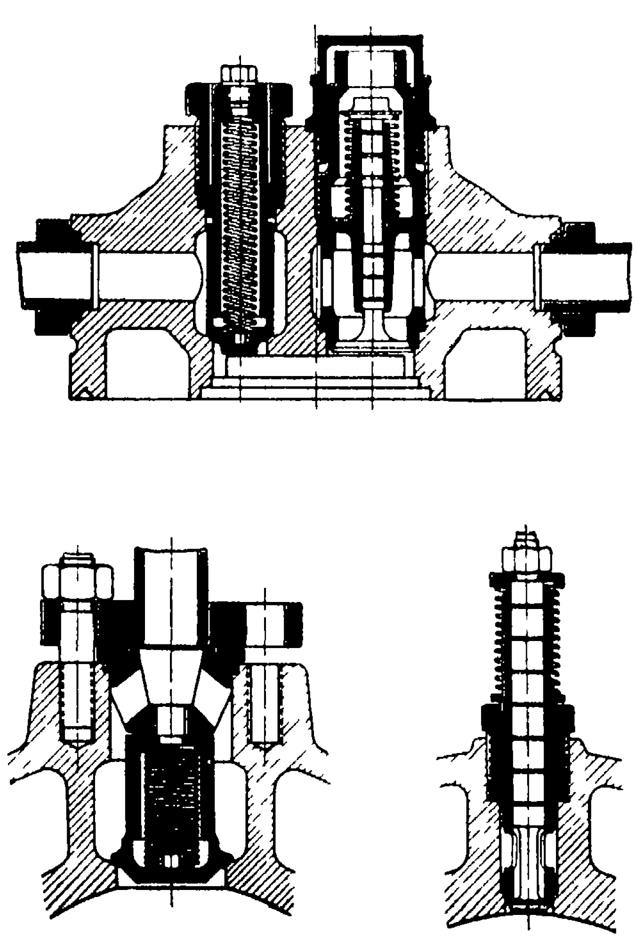


FIG 18 —COMPRESSOR VALVES

time in regular work and with regard to handiness fully answers all the expectations formed of her The insurance companies have made exhaustive tests in this respect with a view to fixing the premiums pay able and have satisfied themselves that the maneuver ing capacity is equivalent to that of a steamship and they have therefore made the premium the same as that customary for steamships The maximum speed of the boat can be reduced by regulating the motor from about 10 miles to about 3 8 miles per hour the revolutions of the motor being lowered from 360 per minute to about 1 0 per minute The lowest attain able number of revolutions is normally about 40 per cent of the maximum The effective horse power in this case is reduced from about 200 to 35 The speed governing of the motor can be effected either by cutting out a cylinder releasing at the same time the fuel pump of the cylinder in question or by regulating the supply of fuel to all the cylinders Reversing is carried out with surprising speed and safety Tests carried out in comparison with similar ships with steam engines have given the following results

TABLE I

	A Steam Tug	B* Motor Tug Frericks
	Seconds	Seconds
I Engine starts from rest [illegible]	4 [illegible]	[illegible]
Engine starts from [illegible]	[illegible]	[illegible]
Engine [illegible] from [illegible] full forward to full astern	1[illegible]	8
Beginning of ship's motion forward from rest	[illegible]	11
Beginning of ship's motion astern	10	1
I Ship [illegible] from full forward to full backward	[illegible]	2
II From rest to full speed astern	[illegible]	10

[illegible] 20 9 m [illegible] 4 86 m [illegible] 2 18 m [illegible] 180 [illegible] 180 [illegible]

[illegible] 18 [illegible] 1 9 m [illegible] 18 [illegible] 300 [illegible]

Thirty maneuvers can be carried out per hour with out alteration of the air pressure in the starting tanks while with the quantity of air stored in the starting tanks 60 consecutive maneuvers can be carried out The starting tank holds 250 liters and when quite exhausted it can be repumped to full pressure in 15 minutes

(To be concluded)

Radioactivity as a Kinetic Theory of a Fourth State of Matter*

THERE are many points of resemblance between the movements of the molecules of a gas and the move ments of those corpuscular radiations with which we have become acquainted in following up the discovery of radioactivity In both cases we find that things of extremely minute dimensions are darting to and fro with great velocity and in both cases the path of any one individual is made up of straight portions of various lengths along which it is moving uniformly and free from external influence and of encounters of short duration with other individuals when energy is exchanged and directions of motion are altered There is even a resemblance in the universality of each movement The motion of molecules is a fundamental fact throughout the whole of our atmosphere and in deed in all material bodies the motion of the radiant particles emitted by radioactive substances is also widely distributed and of great importance Taking Eve s estimate of the usual ionization of the air we can calculate that in this room in every second some thousands of α and β particles enter into existence complete their paths through all the atoms they meet and sink into obscurity some of them viz the α particles as atoms of helium These last move through definite and well known distances in the air For ex ample a third of those which are due to radium products move through a range of just above 4 centi meters an equal number have a range of just below 5 centimeters and again an equal number move through 7 centimeters and the speed is so great that the life of each α particle as such is completed in about a thousand millionth of a second They leave their mark behind them in the ionization of the air through which they have passed and in the heat into which their energy has been commuted The former effect is easily detected by the sensitive measuring in struments which we now possess the latter is too small to measure and must be greatly increased by the aid of radium itself before it can be investigated But on a large scale which takes into account the distribution of radioactive material through the earth the sea and the air the effects are of first rate im portance to the physical conditions of our earth

If we compare the movements a little more closely we find differences as interesting as the resemblances The motions which the kinetic theory of gases con siders are those of the molecules of which gases con sist In the case of radioactivity the things which move are quite different They are sometimes elec trons, which have come to be called β rays when their speed is great and kathode rays when it is somewhat less or they are γ or X rays which are new things to us or if as α particles they are helium atoms such as we have known before they move with ex cessive speeds which give them quite new properties In general the radiant particles move hundreds of thousands of times as fast as the gas molecules do and it is no doubt on account of this fact as well as through their usually extreme minuteness that their power of penetrating matter is so great. When two molecules of a gas collide they approach within a fairly definite distance which we call the sum of the radii of the molecules and the approach is followed by a recession and new conditions of motion Each molecule has as it were a domain into which no other molecule can penetrate But the defences which guard the domain are of no account to the vigorous movements which we are considering now The radi ant particles pass freely through the atoms and their encounters are rather with one or other of a number of circumscribed and powerful centers of force which exist within the atomic domain and act with great power when and only when approached within dis tances which are small in comparison with the atomic radius It is on this account that the new theory opens out to us such possibilities of discovering the arrangement of the interior of the atom Never be fore have we been able to pass anything *through* an atom our spies have always been turned back from the frontier Now we can at pleasure cause to pass through any atom an α particle which is an atom of helium or a β particle which is an electron or a γ or X ray and see what has happened to the particle when it emerges again and from the treatment which it seems to have received we must try to find out what it met with inside

The newer movement exists superimposed upon the other Its velocities are so great that the gas (or liquid or solid) molecules are in comparison per fectly still There is as it were a kinetic theory within a kinetic theory there is a grosser movement of gas molecules which has long been studied and in the same place and at the same time there is a far subtler and far more lively movement which is prac tically independent of the other Your vice president Sir William Crookes was the first to find any trace of it The behavior of the kathode rays in the vacuum tubes which he had made showed him that he was dealing with things in no ordinary condition Whatever was in motion was neither gas nor solid nor liquid as ordinarily known and he supposed it must be possible for matter to exist in a fourth state We have gone far since Sir William s first experi ments The X ray tube and radium have widely in creased our knowledge of phenomena parallel to those of the Crookes tube But I think we may still be glad to use Sir William s definition

There is another very striking characteristic of the newer kinetic theory which differentiates it sharply from the older The experiences of any one of the radiant particles in an atom which it crosses are quite unaffected by any chemical combination of that atom with others that is to say by any mole cular associations it may have Naturally this sim plifies investigation We may no doubt ascribe this state of things to the fact that a radiant particle is concerned rather with the interior of the atom than with the exterior and that it is the latter which is of importance in chemical action

Let us take notice of one more important differ ence The molecules of a gas move with velocities which vary at every collision yet vary about a cer tain mean But the peculiar motion of the radiant particle is only temporary For only a very short time can any ray be described as matter in a fourth state at the end of it the extraordinary condition has terminated the particle has lost its tremendous speed or suffered some other change and the ray ceases to exist Speaking technically we are dealing with in itial not permanent, conditions

Let us now come back to resemblances between the two kinds of motion for there is one point of sim ilarity which is not quite so obvious as others I have mentioned and is I think of the greatest importance, in fact it is largely on account of this similarity that I have ventured to put the two theories together for comparison

When the first experimenters in radioactivity al lowed their streams of rays to fall upon materials of various kinds they found that the irradiated sur faces were the sources of fresh streams of radia tion The secondary rays were sometimes of the same nature and quality as the primary sometimes not. Further they found that the secondaries on striking material substances could produce tertiaries, and so on The examination of all the variations of this problem—the investigation of the consequences of changing the primary of changing the substance, and last, but not least, of changing the form of the experi mental arrangements—has been the cause of an enormous amount of work. There is a large litera ture dealing with secondary radiations of all kinds which I imagine but few have read with any com pleteness and the subject has become, on the surface at least, complicated and difficult. Now I believe that it is possible to clear away the greater portion of this complexity at a stroke by the adoption of a hypothesis which makes it possible to describe and discuss the whole of these phenomena in a very simple way When an encounter takes place between two gas mole cules we suppose that the sum of the energies of the two is the same after the collision as before, and further that there are just two things to consider— two molecules—after as well as before I think that we may carry this idea over almost bodily to the newer theory A radiant particle encounters an atom The particle is a definite thing it contains a definite amount of energy and whether it is an α or β, or γ or X ray its energy is to be found almost entirely in side a very minute volume The encounter takes place When it is over there are still two things an atom and a radiant particle going away from it. The sum of the energies of the two is still the same, which means that we deny a possibility much considered at one time viz that in the encounter the atom could be made radioactive and could unlock a store of en ergy usually unavailable We suppose that there is no energy to be considered except the original energy of the radiant particle, and we suppose that there are not now two or more radiant particles in place of the original one which also is a limitation on previous ideas It is a theory which ascribes a compuscular form to all the radiations Each particle α β γ or X is to be followed from its origin to its disappear ance and we have nothing to think of but the one particle threading its way through the atoms It loses energy as it goes though little at any one col lision and it passes out of our reckoning when it has lost it all There are no secondary radiations other than radiant particles moving in directions which are different from those in which they moved at first. Even when a kathode ray excites an X ray in the or dinary Rontgen tube or the X ray excites a kathode ray in a manner almost as well known it is hardly an exception to this rule The kathode ray has an en counter with an atom and disappears simultaneously the X ray comes out of the atom a circumscribed corpuscle carrying on the energy of the kathode ray There is a change but it extends only to the external characteristics of the carrier of energy The X ray passes through the glass wall of the X ray bulb or at least it does so sometimes it may pass through other matter as well but sooner or later it has a fatal en counter with an atom and the reverse change takes place In all cases in that of the undeviating α ray or the β ray which suffers so many deflections or the γ or X rays it is a matter of tracing the movements of individual minute quantities of energy until they finally melt away

Let us consider one or two simple experimental re sults from this point of view in order that we may il lustrate this corpuscular theory and at the same time may learn something of the properties of the cor puscles and of the arrangements of the atoms through which they pass

We take first one of the simpler cases the move ment of an α particle through a gas The relatively large mass of the particle gives it an effectiveness which the other radiations do not possess. It moves straight through every atom it meets and ionizes most of them Very rarely does it suffer any deflec tion from its course until its velocity is nearly run down Then indeed it does appear to depart con siderably from the straight path and it may be that it is much knocked about by collisions before it finally comes to comparative rest. In this way we may ex plain the distribution of the ionization along its path which increases slowly at first and rapidly after wards until the α particle has nearly finished its journey it then falls off rapidly Considering that the ionization increases as the particle slows down and spends more time in each atom and considering the more broken nature of the path near its end, the reason of these peculiarities is clear enough Apart from its comparative simplicity there are some other very interesting features of the particle s motion It is found for example, that the loss of energy which the particle incurs in crossing an atom is proportional to the square root of the atomic weight very nearly, and there is no certain explanation as yet of this curi ous law And again Geiger has examined the small scattering that does occur, and found that α particles when moving quickly may be swung round completely even by the thinnest films of gold leaf, though the number is so small that the effect would have remained undetected had it not been for the scintillation method which he and Rutherford have perfected He has found that about one particle in 8,000 is returned in this way from a gold plate, which need consist only

* Discourse delivered at the Royal Institution by Prof William H Bragg, F R S

few thicknesses of gold leaf in order to give the maximum effect.

Now let us taken an example from the behavior of β rays. The β particle is so light that it is easily deflected even though it moves several times as fast as the heavier α particle Because it therefore possesses little energy its effects are much smaller and no one has yet succeeded in handling a single β particle in the same way as Rutherford and Gieger have handled the other We are obliged to content ourselves with observations of the effects of a crowd of β particles since the combined action of many is necessary to give us an observable result and at the same time that the β particle gives much less effect than the α it has a much more irregular course so that the problem is doubly difficult We are in fact only just beginning to understand it There is a compensation in the fact that its very liability to deflection makes it all the more interesting an object as is possible—and this is the particular β ray problem I wish to consider now—to examine the deflection of a single β particle by a single atom the parallel result in the kinetic theory of gases has never of course been achieved

Suppose that we project a stream of β rays against a thin plate and measure the relative number sent back which we do by measuring the ionizations caused by the incident and returned rays respectively We do this for varying thicknesses of the plate and plot the results as for example Madsen has done His plate was made of gold leaves which could be had of extreme fineness From the relation thus obtained it is possible to obtain with confidence the amount of β radiation that would be returned by the thinnest plate that could be imagined only one molecule thick In such case the particles turned back could have had but one collision and we have achieved our purpose Madsen's figures show that a plate weighing four milligrams to the square centimeter turned back a tenth of the β particles that fell upon it and so far as can be judged the ratio of the proportion turned back to the weight of the plate would be almost doubled for very thin plates We could go more into detail and find the distribution of those that are returned we should then have data from which we might determine in some measure the distribution of the centers of force inside the atom We cannot follow this up now but I would like to direct your attention to a curious indication which we obtain when we compare the results for gold with those which Madsen found for aluminium They show that the lighter metal turns back fewer β particles and that its power of absorbing a stream of rays is rather an absolute abstraction of energy There is clearly an actual absorption effect which is to be distinguished from the scattering effect Indeed the two effects are obviously of different importance in the two cases When a β ray strikes a gold atom it must be much more liable to deflection than when it strikes the lighter atom of aluminium On the other hand I think it can be shown clearly that in plowing through aluminum atoms there is a relatively quicker absorption of energy We may illustrate this by a rough model Let us stand an electro-magnet upright on the table and let us suspend another magnet so that it can swing over the fixed one and just clear it If we draw back the swinging magnet and let it go toward the fixed one the currents running so that the two repel then as the moving magnet tries to go by there will be a deflection depending on the relative speed the closeness of approach and the strength of the poles This may represent the turning aside of an electron by a center of force inside an atom Now let the magnet at the table be supported by a spiral spring so as to be still upright but have some freedom of motion then when the experiment is repeated the swinging magnet pushes the other more or less to one side It is less deflected but it has to give up some of its energy This is exactly what happens in the case of the β particle The center of force in the gold atom behaves like the stiffer electro magnet on the table It deflects the electron more but robs it of less energy in doing so It will not do to suppose the gold atom to differ from the aluminium atom simply in the number of centers of force such as electrons which it contains if it is supposed that they all act independently There is some other fundamental difference equivalent to a difference in the stiffness with which the electrons are set in their places There are two things to be expressed in the behavior of the atom toward the β particle as has been pointed out several times H W Schmidt has actually calculated them from experiments which gave them indirectly and somewhat approximately The method I have just outlined gives one of them directly viz., that which is called the scattering coefficient, and I think the other can also be found directly by a method which will serve as an illustration of the behavior of γ rays.

We must first, however, consider the part which γ and X-ray play generally in this theory Workers are by no means agreed as to the proper way in which to regard them but there is no need to enter at once on a discussion as to their nature It is well known that they have the most extraordinary powers of penetration and are unaffected by electric or magnetic fields They have one property which alone as I think brings them within our experience that is to say the power of exciting β rays from the atoms over which they pass Were it not for this they would still be unknown When we examine this production of β rays we find that in the first place their speed depends on the quality of the γ rays which cause them and not on the nature of the atoms in which they arise In the second that the β rays to a large degree continue the line of motion of the γ rays as if the latter pushed them out of the atoms and lastly that the number of the β rays depends on the intensity of the γ rays It is these facts which suggest the simple theory I have already described The γ ray is some minute thing which moves along in a straight line without change of form or nature which penetrates atoms with far greater ease than the α or β particle which is not electrified and which sooner or later disappears inside an atom handing on a large share of its energy to a β particle which takes its place The absorption of γ rays is simply the measure of their disappearance in giving rise to β rays one γ ray producing one β ray and no more

We find the same sort of scattering in the case of γ rays as in that of β rays Of a stream of rays directed against a plate which it can penetrate easily we find that a few are turned completely back a very much larger number are only slightly turned out of their path and the rest go on The scattered rays are very similar to the original rays there is no need to suppose that the original ray disappears to be replaced by a secondary any more than there is to suppose that α and β rays disappear and are replaced by others in similar cases When therefore a γ ray enters an atom three possibilities await it The first is a negative one it may go through the atom untouched and this must happen in the majority of cases the second chance is that of deflection and the third that of conversion into a β ray using the word conversion in a general sense without going into details as to the nature of the process

Now we may consider our γ ray problem Suppose a stream of these rays passing over a block of any substance such as aluminium or zinc or lead When they are really penetrating rays they are equally absorbed by equal weights of these materials which means that in equal weights equal numbers of β rays spring into existence If these β rays were able to move through equal weights of the metals we should find in each metal the same density of β rays and the important point is that this is independent of whether the rays are straight or crooked in their paths If ten lines of given length were begun in every square centimeter of a sheet of paper the ink used in drawing them would be independent of the straightness of the lines but proportional to their length Now if we make a cavity in each metal the β rays will cross it in their movements to and fro and if a little air is introduced into the cavity the ionization produced in it will be a measure of the density of the β rays and therefore the average distance each moves in the metal Experiment shows that we get twice as much ionization in a cavity in the lead as in a similar cavity in the aluminium and we conclude that the β particle really has a longer track in the heavier metal This experiment gives us the second constant of β ray absorption that is to say the rate at which its energy is taken away from it the other experiment gave the chance of deflection only We see that the path of a β ray in aluminium is more direct but of less length than in lead in the latter metal it has really a longer path but it does not get so far away from its starting point because it suffers so many more deflections

Finally let us take a problem from the X rays Let us see how we may test the idea that X and γ rays do not ionize themselves but leave all the work to be done by the β rays which they produce Suppose a pencil of X ray to pass across a vessel and to produce ionization therein It is convenient to use not the original X rays which are heterogeneous but the rays which are scattered by a plate of tin on which the primary rays fall Such tin rays as we often call them briefly are fairly homogeneous and give kathode rays of convenient penetration In some experiments of mine the rays crossed a layer of oxygen 3 45 centimeters wide having a density 0 00137 and the ionization produced was 227 on an arbitrary scale The result may be put in the following way Suppose provisionally that all this ionization is done indirectly the oxygen has concerted so much X ray energy into kathode-ray energy and these kathode rays penetrating their one or two millimeters of oxygen, which is all they can do have ionized the gas Then we may say that, in crossing a layer of oxygen weighing $3\ 45 \times 0\ 00137$, or $0\ 00473$ grain per square centimeter enough kathode rays have been produced to cause an ionization of 227 units and therefore that a layer weighing one milligram per square centimeter would produce 48 units in the same way We now proceed to compare this production in oxygen with the similar effect in a metal such as silver Stretching a silver foil across the chamber in the path of the rays we find that under the same intensity of rays the ionization is largely increased and the change is due to kathode rays which the X rays have generated in the silver Not all these rays get out of the silver but we can overcome this difficulty by taking silver foils of different thickness drawing a curve connecting the effect of the foils with their thickness taking the curve back to the origin and so finding what would be the effect of a foil so thin that all the kathode rays did get out In my case I found that a milligram of silver produced enough kathode rays to give an ionization 1 80 This is thirty three times as much as the oxygen could do Now according to our theory this should be because silver absorbs tin rays thirty three times more than oxygen does and experiment showed this to be very nearly the case In finding the absorbing power of oxygen I measured first those of carbon and oxalic acid and then proceeded by calculation for the absorption in a gas is difficult to determine

Two interesting points appeared in this experiment In the first place the ratio between the two quantities of kathode rays which appear on the two sides of a silver leaf through which the tin rays pass is nearly constant for different thicknesses of leaf With the thinnest leaf obtainable each quantity was about half its full value It would have been desirable to have had still thinner leaves but it is fairly clear that the ratio would be nearly the same for extreme thinness The kathode radiation which appears on the side of the leaf whence the X rays emerge is 1 20 times that which appears on the other and we may take it that this would be the case even if the leaf were but one atom thick Thus when an X ray plunges into an atom in which its energy is converted into that of a kathode ray the kathode ray may emerge at any point but there is a 20 per cent greater chance that it will more or less continue the line of motion of the X ray than that it will not In previous work on the conversion of γ ray into β ray energy I have found that the β ray may practically be supposed to continue the line of motion of the γ ray so that there is a great difference in behavior of the two classes of ray in this respect It is remarkable that the scattering of the γ rays shows also a much greater dissymmetry than is found in the case of X rays It looks as if the β rays that appear when γ or X rays impinge on atoms are related rather to the scattered than to the unscattered primary rays Putting it somewhat crudely no doubt it might be said that when a γ or X ray is deflected in passing through an atom it runs a risk of being converted into a β ray in the process so that β rays are found disturbed about the atom in rough proportions to the secondary γ or X rays In the case of γ rays this practically amounts to their all going straight on at first in the case of X rays the distribution is more uniform

Another interesting point arises in this way When the X rays from tin are allowed to pass into the ionization chamber through increasing thicknesses of silver foil the kathode rays grow at a rate which is not represented by the exponential curve usually assumed The amount is for some time more nearly proportional to the thickness of the foil A second foil adds its own effect without destroying much of the one on which it is laid This may easily be ascribed to the relation of the ionization due to the β particle to the energy it has to spend The ionization is nearly all at the end of the path and the second layer does not absorb the rays made in the first because they are still at the beginning of their career

These few experiments which I have described may serve to illustrate both the justice and the convenience of placing all these rays α β γ and X in one class We are tempted to consider them all as corpuscular radiations of some sort and we then look upon our researches into their behavior as attempts to understand the collisions of the various new corpuscles with the constituent centers of force in the atoms But if we ascribe corpuscular properties to the γ and X rays we are led far away from the original speculations as to their nature Stokes supposed them to be spreading æther pulses but in his theory the energy of the pulse spreads on ever widening surfaces as the time passes and is utterly insufficient to provide the energy of the β rays which the γ or X rays excite Some sort of mechanism has to be devised by which the energy of the γ ray moves on without spreading so that at the fateful moment it may be all handed over to the β ray which carries it on I had the hardihood myself to propose a theory of this kind My idea was that the γ or X ray might be considered as an electron which had assumed a cloak of

darkness in the form of sufficient positive electricity to neutralize its charge Nor do I see any reason for abandoning this idea, for it is at least a good work ing hypothesis It means of course that not only does the energy of the β ray come *from* the γ ray but the β ray itself

Many insist that my neutral corpuscle is too ma terial and that something more ethereal is wanted for it appears that ultra violet light possesses many of the properties of X and γ rays It can excite elec trons to motion and sometimes the speed of the elec tron depends on the quality of the light, and not on the nature of the material from which it springs They propose therefore a quasi-corpuscular theory of light γ and X rays being included The immedi ate objection to this proposal is that it seems to throw away at once all the marvelous explanation of interference and diffraction which Young and Fres nel founded on a theory of spreading waves, and I do not think anyone has yet made good this defect. The light corpuscle which is proposed is a perfectly new postulate It is to move with the velocity of light keeping a circumscribed and invariable form to have energy and momentum and to be capable of replacing and being replaced by an electron which possesses the same energy but moves at a slower rate and of course it has to do all that the old light waves did The whole situation is most remarkable and puzzling We are working and waiting for some solution which perhaps will come in a moment unexpectedly Mean while we must just try to verify and extend our facts and be content to piece together parts of the puzzle since we cannot as yet manage the whole My object has been to show you how we may conve niently bind together a large number of the phe nomena of radioactivity into an easily grasped bundle using a kinetic theory which has many points of re semblance to the older kinetic theory of gases

Surface Tension and Lead Poisoning

The surface of the mercury in a barometer is con vex but when a glass tube is partly filled with water the surface of the liquid assumes a concave form A glass tube or rod which has been immersed in water remains wet after it is withdrawn because a film of water adheres to the glass but mercury does not adhere to glass or wet it Every liquid assumes a concave surface when in contact with a solid which it wets and a convex surface in contact with a solid which it does not wet Water does not wet grease and therefore it assumes a convex surface in a greased glass tube and the form of convex drops when sprinkled on a greased glass plate The leaves of plants are covered with a film of wax and for this reason are not easily wetted Dew stands in drops on leaves without wetting the surface and the funnel shaped leaves of some plants collect rain in the form of a large flattened drop which does not wet the leaf. In the absence of wax or grease water readily wets vegetable tissue for which it possesses a strong affin ity When leaves are exposed to long-continued rain their thin coating of wax is gradually washed away and they then become soaked with water

The feathers of ducks and other aquatic birds shed water and do not become wet because they are satu rated with oil This oil is not washed away as the wax is washed from leaves by long-continued rain because the feathers possess a stronger affinity for oil than for water

What has all this to do with poisoning? Prof O N Witt gives the answer in a long and very entertaining article in *Prometheus* from which only the essential facts are here cited

White lead like the feathers of birds is more easily wetted by oil than by water and when once saturated with oil is permanently protected from the action of water and aqueous solvents Hence though white lead is very poisonous it can be safely used as an oil paint even in kitchens House painters and artists have long since ceased to use dry ground white lead which is both troublesome and dangerous to work with and buy white lead ground in oil In this way the danger of lead poisoning is removed from the painter s shop but not from the white lead factory where the white lead is first dried in heated rooms then finely ground and finally ground again with oil Although every precaution is taken in these operations it is impossible to prevent some of the poisonous white lead being scattered as fine dust in the air which the workmen breathe

One day a genius whose name is lost to fame reflected that as white lead is produced in the wet way as a chemical precipitate it is already as finely divided as possible and that there would be no neces sity for grinding it if it were not agglomerated by drying But is it necessary to dry a substance which possesses so much greater affinity for oil than for water? Experiment proves that when the wet precipitate of white lead is ground with linseed oil, the water is expelled and rises to the top of the mass as a clear liquid which can be poured off The few drops of water which adhere to the pigment are care fully wiped off. This new process almost entirely eliminates the danger of lead poisoning by white lead dust scattered in the air of the factory

Magnalium Equalizers

An apparatus whose function is to acquire the poten tial prevalent at the point at which it is placed, thus rendering it accessible to measurement, is termed an equaliser To illustrate its use by an example, we may suppose that the upper of two metal plates *A* and *B* shown in Fig 1 to be charged from a storage bat tery so that an electrostatic field is established whose direction is indicated by the three arrows, represent ing lines of force between the two plates. An equal izer *P* connected to an electrometer then indicates the potential at the point occupied by the equaliser

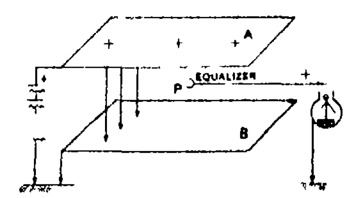


Fig 1

Different types of equalisers have been employed Among these may be mentioned the familiar points or combs diagrammatically represented at *a* in Fig 2 The form shown in Fig 2 *b* depends for its action upon the discharging properties of a stream of water droplets while *c* indicates a similar use of a flame and *d* is intended to denote diagrammatically the use of radioactive substances connected to the electro meter to effect equalization

The mode of action of this last type of device may be briefly outlined as follows The radioactive preparation consisting as a rule of a sheet of platinum coated with polonium strongly ionizes the air in its immediate proximity thereby rendering the same con ducting So long as there exists any difference in potential between the equalizer and its surroundings the ions bearing the corresponding charge fly to meet the plate and charge it up to the proper potential.

All these forms of equalizers possess certain disad vantages which render them ill adapted for the investi gation of the electrical conditions of the atmosphere In the case of balloon ascents the flame type of equal izer is out of the question The water drop equalizer requires frequent attention and polonium is a costly material It is therefore gratifying to hear that another type of instrument has recently been intro duced which depends on a certain action of light, and which is in many respects superior to the older forms. It has been known for some time that plates of zinc or aluminium with a freshly exposed bright surface exert an equalizing influence under the action of light This effect however dies down very quickly Recently however it has been shown by Dember that the alloy of magnesium and aluminium known as magnalium is peculiarly well adapted for use as an equalizer Freshly scraped magnalium retains its equalizing prop erty for several hours and when it has lost its activity it can very quickly be restored by simply polishing its surface

It seems then that we have now a thoroughly satis

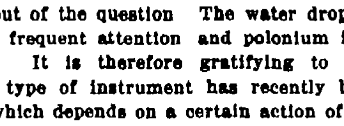


Fig 2

factory agent at our disposal and one which is not dependent upon narrowly prescribed laboratory condi tions but which will readily adapt itself to the exigen cies of circumstances —Excerpt from *Prometheus*

The Great Red Spot of Jupiter

Jupiter, the giant of our family of planets is now in a very favorable position for observation It was in opposition to the sun on May 1st, will be visible all night during the entire month of May and will be evening star until September

This great planet, which possesses 1 300 times the bulk and 310 times the mass of the earth accom plishes its rotation on its axis in 9 hours and 50 min utes As the equatorial circumference is 275 000 miles, the linear rotational velocity of a point on the equator is nearly 8 miles per second In consequence of this enormous velocity or rotation the planet is greatly flattened at the poles.

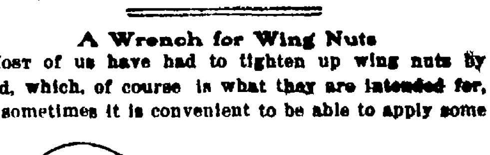
The telescope shows a series of bands or belts crossing the planet's disk parallel to the equator and continually changing in width, form, [illegible] general appearance. They are sometimes called [illegible] clouds, but they more probably represent currents [illegible] the mass of the planet, somewhat analogous [illegible] terrestrial Gulf Stream. The whole globe of Jupiter is composed of parallel circular currents, moving with different velocities, the equatorial current being the swiftest. A similar phenomenon is observed in the sun, which does not rotate as a rigid mass, but moves most rapidly at the equator The velocity is not even constant for the same current. Spots near the equator of Jupiter, which accomplished a complete rotation in 9 hours 50 minutes and 6 seconds in 1[illegible], occupied 9 hours, 50 minutes and 24 seconds in performing the rotation in 1895. In short, Jupiter is a planet which is not yet solidified

A very remarkable detail of the surface of Jupiter, which is sometimes very conspicuous and at other times is barely perceptible (probably owing to clouds in the planet s atmosphere) is a large oval spot of ruddy hue situated in the southern equatorial belt, between 25 and 30 degrees of south latitude. This spot is 26 000 miles long and 9,300 miles wide, and it covers as large a proportion of the planet's surface as Australia covers of the surface of the earth The red spot moves a little less swiftly than the equatorial current and with a slightly varying velocity accomplishing its revolution about the planet in 9 hours, 55 minutes and 35 seconds in 18[illegible], and in 9 hours, 55 minutes and 42 seconds in 1900.

In a contribution to the April number of *L'Astronomie* quoted in *Cosmos* Antoniadi expresses the opinion that this great red spot is the first continent in process of formation on the liquid surface of Jupiter This floating continent or island is still only a thin crust for although the materials of the current in which it floats are observed to be deflected by it and to skirt its shore the Spanish astronomer Sola has also seen these materials vanish at the eastern shore and reappear at the west, as if they passed be neath the continent The terrestrial granitic conti nents in their initial stage of formation were likewise thin crusts floating on the surface of the hot and liquid globe

A Wrench for Wing Nuts

Most of us have had to tighten up wing nuts by hand, which, of course is what they are intended for, but sometimes it is convenient to be able to apply some



A WRENCH FOR WING NUTS

tool for the tightening up of these nuts For such a purpose the simple little tool illustrated in the accom panying line engraving taken from the *Horseless Age* will be found convenient. The wrench is made of flat stock about 3/16 inch thick. The handle *A* is made in various sizes according to the size of the wing nut five times the distance across the wings of the nut being the usual practice Two slots *B* are cut at right angles to each other in the circular part of the wrench as shown. At their intersection the central opening is enlarged so as to permit the screw on which the wing nut turns to enter —*Machinery*

Black English Stone Pulp.—Heat pumice stone to redness quench it with water crush it to a fine powder and sift through a hair sieve. Put the pow der into a suitable vessel and add enough varnish to make a thick paste Add lamp black, then more var nish and rub it down until the fluid is uniform With this mass well beaten cardboard or double paper is coated dried coated a second time, then dried and pressed

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The Heilmann Suspension for Automobiles

By Jacques Boyer.

In automobiles of the usual construction the center of gravity is higher than the axles The result is extensive vibration of the vehicle and torsion of the springs. Moreover the shocks caused by inequalities of the road are transmitted directly from the wheels to the axles. The springs attached by their middle posts to the axles follow the oscillations thus produced, but the chassis and the body of the car, which are suspended from the ends of the springs are prevented by their inertia from following these rapid vibrations Hence the springs and their connections are strained and are soon worn out. In light cars these defects are party obviated by pneumatic or solid rubber tires but the vibrations of heavy vehicles cannot be overcome by these very costly additions.

An elegant solution of the difficulty has been proposed by J J Heilmann, the inventor of the first electric locomotive In the Heilmann compound suspension for automobiles all oblique bearings and torsional stresses are eliminated, and the center of gravity is brought as near the ground as possible while the weight of the car acts along the vertical lines which pass through the centers of the wheels and the points of contact with the ground but is borne entirely by the hubs and not by the axles

The details of construction are shown in Figs. 1 and 2, which represent vertical sections of the vehicle in the planes of the rear and front axles respectively The weight of the chassis and body is carried by the rear and front supporters *a* attached to the longitudinal bars *b* of the chassis These supporters pass over and outside the wheels and rest on the hubs *c* Each wheel is absolutely independent The axles *d* carry no weight except their own and serve merely to connect the wheels together They are connected to the front hubs by Cardon joints *e* and to the rear hubs by balls *f* Each wheel is consequently free to rise independently of the others in surmounting obstacles The axles move freely in guides *g* attached to the chassis.

The weight is transmitted to the hubs by the following mechanism Each hub turns in all bearings *i* in a saddle *h*, which has four lugs of which two are above and two below the hubs These lugs are attached by short suspending links to the ends of two carriage springs of the ordinary type *l* with their concave sides below The two sheaves *m* which are bolted to the middle parts of the springs are connected with each other by an ovoid frame *n* which surrounds the saddle without touching it at any point

Fig 5—WHEEL OF CAR WITH HEILMANN SUSPENSION

The outer portion *o* of the supporter *a* rests on the spiral spring *p* which rests on the upper spring sheaf *m*. Vertical rods *r* attached to the top and bottom of the saddle *h* pass through tubes rigidly connected with the upper and lower spring sheaves *m* and guide the wheel in rising over obstacles The Cardan joints allow the front wheels to be turned around a vertical axis in steering The tires are composed of chrome leather very strongly compressed which nearly eliminates the noise produced by the rolling of the wheels

The diameter of the wheels is 4 feet and 5 inches, but as the weight is borne by the supporters described above and not by the axles the center of gravity can be brought lower than in a car of the usual type with much smaller wheels The large wheels possess the advantages of better adhesion to the ground diminished coefficient of traction and smaller velocity of rotation for a given speed of travel—not to speak of their esthetic superiority The weight of all the springs of a car designed to carry a load of 4½ tons in addition to its own weight does not exceed 135 pounds

Another distinctive feature of the new Heilmann car is a system of steering which is entirely independent of the various connections and mutual reactions between the front wheels and the chassis which are described above so that the wheels can be turned without regard to their momentary positions relative to the chassis The mechanism by which this result is produced is shown in Figs 3 and 4 which represent respectively side and front elevations of the steering gear The rotation of the steering wheel 1 transmitted to the endless screw 2 moves the nut 3 which by means of the fork 4 causes the bent lever 5 to turn on its point 6 which is attached to the chassis 7 The lever 5 is connected by the link 8 and the joints 9 and 10 with the support 11 which slides along the guiding rod 12 attached to the chassis by the bars 13 The support 11 has a vertical slot containing the sliding piece 14 which is jointed at 15 to the plunger 16 This plunger penetrates more or less deeply into a cylinder 17 which is attached to the wheel by means of the piece 18

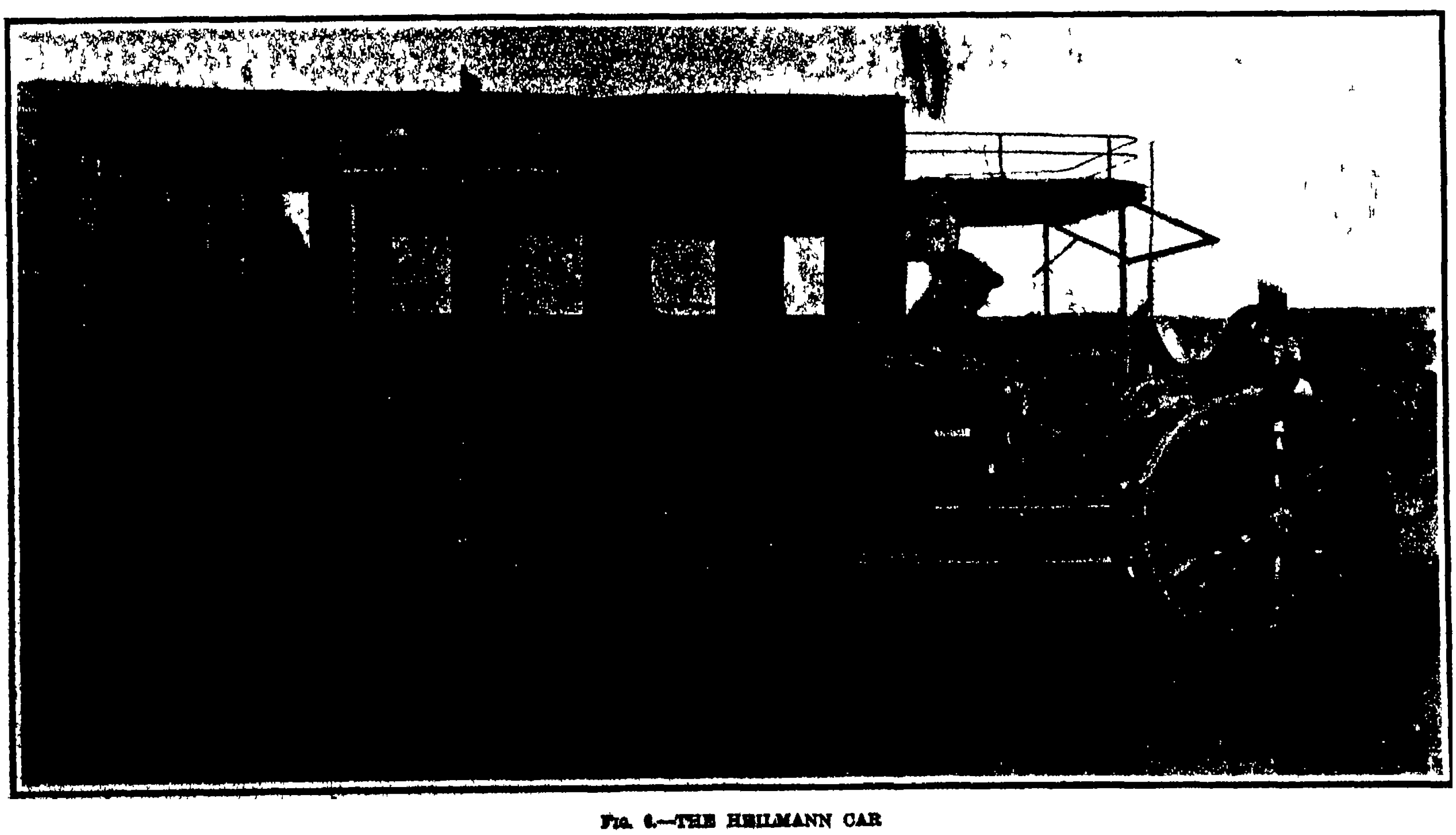


Fig. 6.—THE HEILMANN CAR

Hence when the support 11 is moved forward or backward by turning the steering wheel 1 as has been explained the motion is transmitted by the sliding piece 14 to the extensible steering lever which is composed of the plunger 16 the cylinder 17 and the piece 18 and the wheel to which this piece is attached is turned to the right or left through an angle which corresponds with the position to which the support 11 is moved along the guiding rod 12 and also with the depth to which the plunger 16 penetrates in the cylinder 17 The freedom of movement of the sliding piece 14 in the slot of the support 11 allows the entire steering lever composed of 16 17 and 18 to rise and sink with the wheel as the latter passes over obstacles without interfering with the operation of steering

The Heilmann car no doubt needs some improvement in details and a more pleasing appearance may be given to the rather heavy vehicle by skillful constructors In any case the Heilmann suspension which aims at no less than the greatly desired elimination of rubber tires both solid and hollow constitutes an important advance in automobile construction

Light-Weight Alloys for Aerial Engines and Aeroplanes*

It is generally recognized that future improvements in aerial navigation will be greatly facilitated by a decrease in the weight of the machinery With this end in view metals or alloys of low specific gravity are being eagerly sought to supplant the heavy metals generally in use The field of investigation however is so far very narrow it being at present limited to the two metals aluminium and magnesium The alloys so far developed consist of various proportions of these two elements modified by small additions of heavier metals

A number of alloys of this type have been experimented with and several have been patented The best known are duralum and magnalium One of the latest discoveries in this line is called duralumin which is of German origin as in fact are most of the light alloys Extraordinary claims are made for this alloy It is stated that it has practically all the properties of steel that it can be drawn rolled stamped or forged either hot or cold that its tensile strength ranges from 30 000 to 88 000 pounds per square inch according to its degree of hardness and that these qualities are found in an alloy containing from 90 to 95 per cent of aluminium so that the specific gravity is very nearly that of aluminium

Duralum contains copper and phosphorus in addition to magnesium The composition is given as 79 per cent of aluminium 11 per cent of magnesium and 10 per cent of phosphor-copper The percentage of phosphor in the copper is very low—only 0 5 per cent It is likely that the composition of this alloy however is slightly modified in practice because 10 per cent of copper is exceedingly high even in the absence of magnesium and when the hardening effect of 11 per cent of this latter metal is taken into consideration it would seem that an alloy of the composition as given would be too brittle to be of any practical value

Magnalium is composed of aluminium and small percentages of magnesium an analysis showing from 1 58 to 1 60 per cent of this latter element It also contains small percentages of copper nickel tin and lead the last mentioned metal probably being an impurity The specific gravity of this alloy varies from 2 5 to 2 57 According to Prof J W Richards the tensile strength of magnalium sand castings containing 2 per cent of magnesium is 17 900 pounds per square inch with an elongation of 3 per cent while with 10 per cent magnesium the tensile strength is increased to 21 400 pounds per square inch with a 2 4 per cent elongation It will be seen that the addition of magnesium hardens the metal Chilled castings of magnalium with 2 per cent magnesium have been found to possess a tensile strength of 28 600 pounds per square inch with an elongation of 2 per cent, and 10 per cent magnesium alloy chilled castings have a tensile strength of 33 600 pounds per square inch and an elongation of 3 40 per cent This is a peculiar condition as compared with that of sand castings The same peculiarity is found in water-chilled castings, where the 2 per cent alloy has a tensile strength of 40 000 pounds per square inch and a ductility of 1 per cent while the 10 per cent alloy has a tensile strength of 61 100 pounds per square inch with an elongation of 4 70 per cent.

In another series of light-weight alloys aluminium is replaced by magnesium for the basic metal. This produces a lighter alloy, as the elements of high specific gravity with which the magnesium is alloyed exist only in small proportions Alloys of this kind contain from 80 to 95 5 per cent of magnesium the remainder being made up of other metals, principally aluminium These alloys it is claimed can be readily machined, soldered welded forged and cast. An alloy of 92 per cent magnesium and 8 per cent aluminium has a specific gravity of 1.75 and is claimed to be equal in strength to the best gun metal, although the metallurgist may doubt this broad statement. The difference in general between gun metal or bronze and the light-weight alloys is that gun metal may combine high tensile strength with great ductility while the alloys of low specific gravity are more of the nature of cast iron and high tensile strength is obtained only at the expense of ductility Various useful magnesium alloys have however been produced such as electron and ruebel bronze These will no doubt be found of great value in the construction of aerial machines but there is a danger of their being discredited by extraordinary claims by the makers which will cause them to be used for purposes for which they are not suited

There are a number of light weight metals besides aluminium and magnesium but there is no likelihood of their being used for practical purposes on account of their scarcity Among these metals are lithium rubidium and beryllium Lithium is the lightest of all metals known its specific gravity being only 0 57 It possesses however but few of the qualities usually associated with metals It is very soft, and melts at a low temperature and it is hardly likely that it can be used in sufficient quantity with other metals to appreciably lower their specific gravity in order to produce a light weight alloy Rubidium and beryllium both having specific gravities of from 1 5 to 1 7 are too expensive to be of any commercial value at the present time The last mentioned metal has many qualities which would make it a desirable one for aerial work but the ores of this metal do not occur in sufficient quantities to justify the prophecy that it will ever be used as extensively as aluminium, although this latter metal only a comparatively few years ago also was very expensive. It is therefore, likely that nearly all investigations relating to light weight alloys will continue to be based on combinations of magnesium and aluminium with small percentages of heavier common metals

* Abstract from an article in *The Foundry*

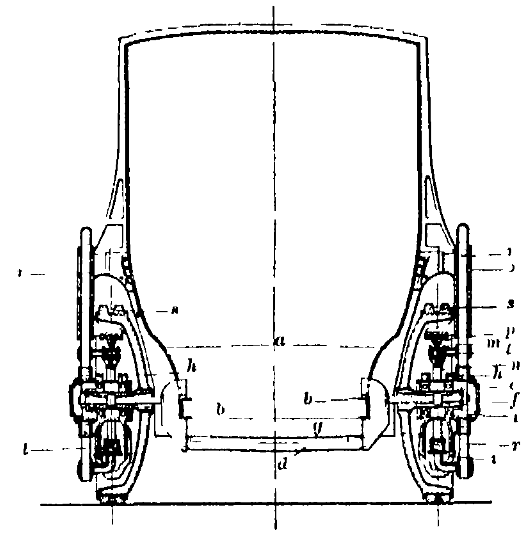


FIG 1 THE HEILMANN SUSPENSION
Vertical Section in Plane of Rear Axle

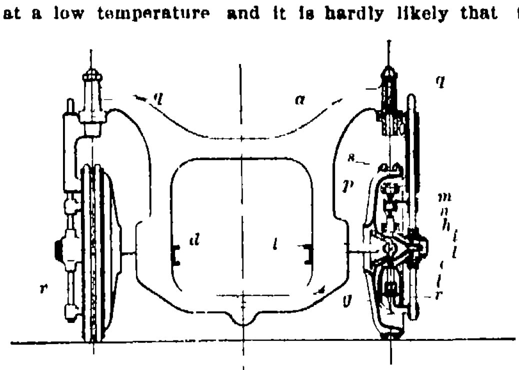


FIG 2—THE HEILMANN SUSPENSION
Vertical Section in Plane of Front Axle

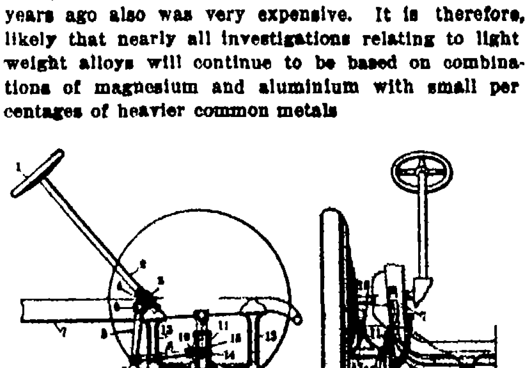


Fig. 3—Side Elevation Fig. 4—Front Elevation
HEILMANN STEERING GEAR

Greek Marble

WITH reference to the architectural glories of classic antiquity, it may be said that two special advantages came to the aid of the artist's genius and the skill of the constructor These were superior climate and super-excellent material. It has been pointed out that, were it not for the perfection of their marbles, it is questionable whether even the fine climate of the Mediterranean would have stimulated the architects of Greece and of Rome to create almost imperishable constructions to be objects of admiration and attempted imitation in our own day, and it remains a curious fact that we moderns still have to turn to the quarries of classic times for statuary marble while it has been contended only Greece can yet supply the finest marbles for constructive purposes

During the fifteen hundred years that followed the destruction of Greek independence art culture practically disappeared from the land While the Moors of Spain were patrons alike of art and learning, and saved much of the science and many of the literary masterpieces of classic times from destruction the Turk seems to have been too busy with the scimitar to have encouraged any arts but those pertaining to the comfort of the governing classes

The famous marble quarries of the Pentelikon near Athens remained therefore undisturbed and silent until the last century when after the coronation of the first King of Greece the erection of a royal palace again called attention to the national wealth in the finest of stone The road to the foot of the Penteli hills was reopened the bridges repaired and a large quantity of the famous old marble employed in the construction of a new Athens.

It was wisely decided that the old Greek quarries should remain untouched so that we have clear evidence of the mode of working these in other times Although the layers are not horizontal but are dipping inward the blocks have all been cut and removed by wedges horizontally to the vertical smoothly chiseled walls The quarries form therefore a series of gallery like right angle stone chambers from which perfectly regular parallelopipedic stone blocks of every size even to the largest, were taken as the thickness of the layers had not to be considered in this manner of extraction

As the modern system is, however to prevent diagonal stratification and also to avoid the more readily weathered seams of mica shale, the marble is preferably quarried from its natural layer This Pentelikon marble forms a great part of the ranges and, fortunately the upper portion The lower part up to five hundred and fifty feet is limestone in transition but thence up to eleven hundred feet it is pure marble

The Pentelikon marble is harder has a finer grain and is said to be in every respect superior to the much vaunted Carrara marble of Italy

Greece not only supplies the Pentelikon pure white marble accepted as the best of building stones but furnishes also fine black and yellow marbles Then too there is the beautiful *Rosso-Antico* presenting streaks of blood and fire in a broad belt, as well as the *Verdi Antico* from one of the islands with its beautiful mottled varieties

Model of a Detached Escapement for Pendulum Clocks

MR A MALLOCK exhibited, at the recent soirée of the Royal Society a model of a detached escapement for pendulum clocks, which also illustrates a simple method of keeping the density of the air surrounding a pendulum constant. The pendulum is "free" in the sense that during the swing it makes no intermittent contacts with any solid Near the end of each swing an electric contact is made by a fine wire dipping in a mercury cup The current then established passes through the coils of an electromagnet which, by means of a 'remontoir working a reciprocating lever causes a very weak spring, to act so as to maintain the oscillation. Constant density in the air surrounding the pendulum is approximately secured by the covering bell glass, whose edge dips in a deep but narrow annular canal, partly filled with mercury An alteration of one inch in the height of the barometer alters the density of the inclosed air by about one part in a thousand.

Electric Lamps and Wireless Telegraphy

THERE is reported in Germany a curious instance of the capture of a wireless telegraph message by an electric lamp An inhabitant of Brunswick, who had such a lamp in his laboratory, was surprised to observe that its brilliancy varied with the unmistakable rhythm of Morse signals. Not only did the light vary, but the sounds always given forth by the arc of the lamp varied in consonance. With a little attention he was able to decipher a message which was being sent out from a radio-telegraphic station three kilometers—nearly two miles—away.

The Electrolytic System of Amalgamating Gold Ores

The Electro-chemist in the Mine

By Elmer Ellsworth Carey

The increasing demand for gold has turned the at tention of miners and metallurgists to new fields and new methods, and every year brings down the cost of mining and milling new extraction methods are being tried, and every effort is being made to save values in low grade and refractory ores The tailing piles of yesterday are now being reworked and to-morrow the tailings piles of to-day will yield further values as the march of progress discloses new methods sys tems and appliances

The favorite ore of the miner is the so-called free milling' In such ore the gold particles are com paratively large and are generally imbedded in quartz free from sulphur arsenic etc Values in such siliclous ores may be recovered by the standard sys tem of amalgamation Then there are other ores where crystals of iron pyrites (sulphides) are found in the quartz and within the pyritic crystals may be found gold particles in a finely divided state The values in such crystals cannot be re overed on the usual mill plate as the particles of gold are coated with various substances preventing amalgamation The present practice is to separate the pyritic crystals from the crushed ore by various types of concentrat ing tables This so-called concentrate is then sent to a smelter or it is ground in tube mills (100-200) mesh and delivered to the cyanide tank where the extrac tion ranges from 85 to 96 per cent.

Concentrates can only be sent to a smelter where the values are high enough to pay transportation and reduction charges the cyanide process is expensive and unsatisfactory unless we admit Mr Clancy s claim that he has solved the cyanide problems by his system of electrochemical cyanidation.

Another method calls for fine grinding (100 mesh) and electro-amalgamation An ideal plant for this process consists of some type of rotary crusher with outside screening possibly a secondary crushing de vice to finish the work of the first crusher and from *the crusher the pulp ground sufficiently fine to re* lease all economic values is passed over electrolytic amalgamating devices The released values are re covered in the form of amalgam Concentration cyanidation and smelting are unnecessary and the metallurgy of gold is reduced to its lowest terms

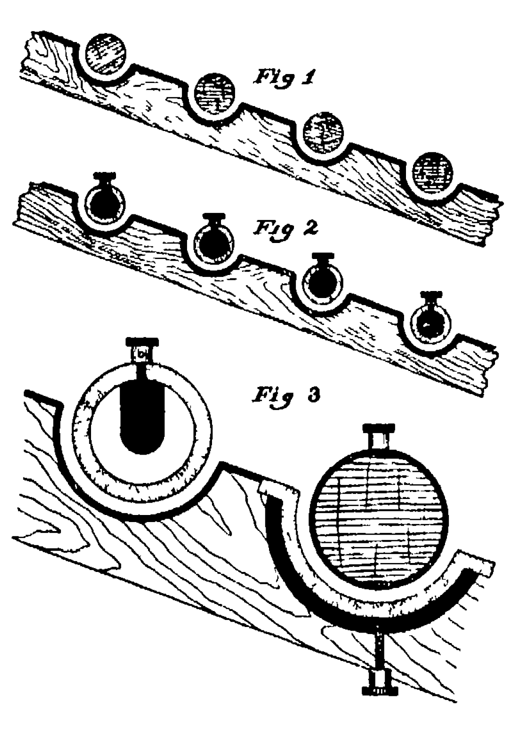
The theory of electrochemical amalgamation has been before the mining world for half a century one of the earliest authoritative papers on the subject may be found on p 205 of Vol I of the Proceedings of the (London) Institution of Mining and Metallurgy Early investigators found as many difficulties as the pioneers in the art of aviation With no informa tion no reserve of text-book knowledge no authorities to consult no works on electrochemistry it is not strange that the electrolytic method of gold recovery made slow progress All the problems of current density anode troubles forms of construction etc had to be laboriously and expensively worked out To obtain working data regarding the system will cost an independent observer several thousand dollars and a year or two of time beside he will draw heavily on his stock of good nature patience and perseverance

In electrolytic amalgamation the sole function of the electric current is to deposit hydrogen sodium potassium or ammonia in the mercury The sole func tion of sodium or potassium is to de-oxidize water and the final work in the chain of reactions is the liberation of nascent hydrogen at the surface of the mercury As the particles of gold sweep over the electrolytically excited mercurial surface all sub stances usually preventing amalgamation are auto matically and almost instantly destroyed or rendered inert. Grease is saponified by the caustic soda oxide coating on gold particles is reduced by hydrogen in a word, gold particles are cleaned and amalgamation quickly follows.

It has been known for some decades that in some way amalgamation was intensified in the presence of the electric current, the problem was to devise a ma chine to utilize the electrical action to the best ad vantage Many complicated devices for this purpose have been patented, but as is usually the case the suc cessful apparatus is simple—almost childishly simple So simple is the device that extracts all released values, and so broad are the claims made for it that the builders of our metallurgical temple have persist ently rejected this stone. I will follow the scriptural allusion no farther, but I earnestly suggest that in dealing with any difficult extraction problem the claims of electro-amalgamation be considered.

* [illegible] mercury wells are described in Vol. II [illegible] American Electrochemical Society, of Prof R H Richards work on ore dressing by making the baffle in such wells an anode using suit able material and employing an 8 to 12 volt current of high amperage we have an electrolytic amalgamating device The objections to the use of such mercury wells disappear when they are electrified and their ex traction efficiency is greatly increased The interior of such wells must be lined with some very refractory substances The ideal amalgamator provides a method by which the gangue is brought closely and intimately into contact with a mercurial surface which acts as a cathode provide these conditions and arrange for suitable capacity and durability etc and the low grade and refractory ores of the West soon yield their gold

To day the mining industry is at a standstill be cause new conditions call for new methods The old style mining engineer must give way to the metal lurgical and chemical engineer There are no prob lems in metallurgy that cannot be solved by the appli cation of the proper electrochemical principles Elec trochemistry has devised profitable methods of ex tracting the useful metals from other ores and electro chemistry will also find methods for releasing the



noble metals from Nature s refractory grasp There is more gold in the West than has been mined lying in plain view in tailing piles low grade veins desert sands beach and river deposits of the West there is sufficient gold awaiting the electrochemical engineer to pay the combined national debts of the world There will be no great advance in the mining industry until the technical schools have furnished a supply of electrochemical metallurgists for the problems of the mining industry to-day can only be finally solved by the electrometallurgist

Mr Clancy has spoken rather disparagingly of the electrolytic system of gold recovery He says One of the most severe criticisms on electrolytic processes is where the direct precipitation of the values from the ore pulp is concerned the objections probably be ing due to the scouring of the plates by the circulating ore and the consequent loss of finely divided gold amalgam in the ore pulp

With the use of the electrolytic sodium mercury cells, as above mentioned there is no scouring of the plates and no loss of finely divided gold amalgam on the contrary mill pulp after passing the electro lytic sluices, contains only encased values The aqua regia test shows no free values It is true that the electrolytic plate amalgamation to be successful re quires considerable experience in the art, but it is possible to arrange electrolytically excited amalgam plates so that the dire results mentioned by Mr Clancy do not occur Electrolytic amalgamation will give extraction results equal to electrolytic cyanidation, and when cost of installation operation and mainte nance is considered, all comparison ceases. Scores of investigators in the last twenty-five years have given testimony as to the efficiency of electrochemical cyan idation the method of regenerating the cyanide solu tion and the recovery of values not amenable to straight cyanidation have frequently been referred to in the technical and mining journals Mr Clancy de serves credit for calling attention anew to the utility of electrolytic lixiviation and his standing is such that many engineers will doubtless turn their atten tion to electrolytic process However I regret that Mr Clancy should have found it necessary to disparage electro amalgamation which is now slowly being rec ognized by progressive mining engineers as an im portant factor in milling But let no one imagine that he can run a few wires from a power line into a solu tion tank and have a successful electrolytic cyanide plant and let no one imagine that he can connect his battery plates with a low voltage generator and thereby greatly increase the extraction This would be on a par with the village mechanic who purchased working drawings of an aeroplane and set out to build a flying machine

A simple but very interesting experiment which may throw some light on the wonderful activity of hydrogen sodium amalgam and the value of electro lytic amalgamation is made by placing a piece of plastic sodium amalgam the size of a pea in a test tube and adding an ounce of water heavily saturated with ammonium chloride Test the amalgamating powers of the very curious resultant amalgam by copper and iron wire

Those who wish to investigate the records of the Patent Office for progress in electrolytic amalgama tion will find the various types of electric amalga mators described in the following United States patents

626 099	579 211	592 793	418 134	370 366
402 711	669 058	548 265	307 081	285 523
641 360	690 524	328 [illegible]	757 557	497 958

DESCRIPTION OF APPARATUS

An electrolytic amalgamating apparatus should be *so constructed that there is a constant and regular* electro-deposition of sodium (or some similar ele ment) in the mercury and provision must be made for passing auriferous pulp or sand over the mercurial surface so that every particle of gold is forced into intimate contact with the mercury With the auto matic deposition of sodium and suitable mercurial contact no free values can possibly escape and the ideal milling plant of the future will consist of some type of rotary crusher producing a 100 mesh product followed by a series of electrolytic amalgamators Such an arrangement will extract all values shown by any free gold test

The ideal electrolytic amalgamator consists of a series of electrolytic sodium mercury cells followed by another electrolytic amalgamating device in which the values are recovered on silver plated copper plates of suitable construction With the mercury wells high amperage may be employed liberating large vol umes of hydrogen which removes all coatings (oxides sulphides grease talc silicious coatings etc) from the microscopic gold particles In the secondary amal gamator the plates offer a large cathode area so that all portions of the pulp are forced into contact with a highly active mercury surface The supplementary amalgamating device above mentioned consists of a silvered copper plate of suitable width this plate con tains parallel transverse semi cylindrical depressions (grooves pockets or riffles) the full width of the plate into these grooves project cylindrical terra cotta cylinders having a quarter inch clearance from three to four inches in diameter these cylinders contain a graphite core one inch in diameter connected as an anode

The pulp passes under the cylinders and sweeps gently over the curved (cathode) amalgam plate while gravity the force of the water and centrifugal force tend to drag each gold particle into contact with the highly excited mercury surface With such a series of amalgamating riffles supplied with a low voltage current of proper density we have an amal gamating device of wonderful activity It is not too much to say that this simple device will extract 99 per cent of the values which may be saved by any sys tem of lixiviation the cost of extraction being insig nificant.

Fig 1 shows a section of a new type of mill plate which I have devised The sides are not represented The silver plated copper plate (being of the usual length of amalgamating plates) contains transverse parallel semi-cylindrical grooves into which fit solid cylindrical wooden baffles, these baffles may also be made of standard piping or casing, from three to four

inches in diameter with the ends closed The clearance between the plates and the baffles is from three sixteenth to one-quarter inch One piece of copper plate may be used with the proper depressions pressed therein or preferably a number of overlapping plates may be used each plate containing one or two semi cylindrical depressions The plates are held in position by their own weight fitting closely to the sides and can be quickly removed from the device for cleaning up The device may be given any desired grade and the plates are dressed and operated as the usual mill plate A mill plate arranged as described will make a better extraction on the average ore than the usual type of amalgam plate there being no loss of amalgam

In Fig 2 is illustrated an electrolytic mill plate constructed similarly to the one shown in Fig 2 which will not only recover all values saved by the standard types but in addition all free values in siliceous pulp and slimes all values in placer material beach sand and all black sand values are also recovered The cylindrical baffles are made of terra cotta and each contains a graphite core connected to the positive lead of a low voltage generator the amalgam plates are connected to the negative lead of the generator

In the first groove or riffle shown in Fig 3 the water and pulp passes over the amalgam plate as in Fig 2 in the second riffle of Fig 3 the amalgam plate connected to the negative lead forms a casing for the baffle and the pulp stream passes *under* the mercurial surface thus bringing the surface of the water into intimate contact with the electrically excited mercurial surface or a copper cylinder, silver plated may be used as a baffle and at the same time act as an amalgamating surface. A gold saving device may consist of a series of such riffles as shown in Fig 3 arranged alternately such an arrangement is particularly useful in treating pulp containing gold in a finely divided form or for recovering values in slimes or in solutions By screening placer material to 10 or 12 mesh and passing the under-size over an electrolytic amalgamating sluiceway of suitable length all fine rusty float coated and greasy gold is recovered

With the standard system of mill plate amalgamation many difficulties are encountered with the device just outlined all the usual amalgamation troubles disappear The plates may be dressed by hand in the usual manner once a day by adding a mercuric solution to the water the proper amount of mercury will be deposited electrolytically to keep the plates in excellent condition Electrolytic sodium amalgam containing gold is soft, yet tenacious, it is plastic and arrests every particle of passing gold, yet such amalgam never crumbles Such an apparatus will extract [illegible] gold from material having any kind of gangue, clayey, sulphurous, arsenious, etc, and there is no fouling [illegible] formation of sulphide coatings, no discoloration by tellurides arsenides, etc.

In certain classes of base ores it may be necessary as a preliminary measure to treat the pulp for 30 minutes by electrolytic pan amalgamation before passing the pulp over the electric sluice, and for ores containing gold in chemical combinations (sulpho-tellurides etc) a preliminary roasting may be required.

In the near future we may look for a greatly increased production of gold due to the application of electrochemical methods in mining and milling operations were electro-amalgamation and electro-cyanidation to-day in general use in other mills now in operation the gross output of gold would be increased [illegible] per cent The great increase in the future supply of gold however will come from vast low grade deposits and ledges which cannot now be economically mined A new field containing fabulous treasures awaits the command of the modern Aladdin—the electrochemical engineer

Proposed Applications of Electric Ship Propulsion

The Explanation of New Designs

By W L R Emmet

The writer has published a previous paper on the subject of electric ship propulsion and has in that and elsewhere given out a good deal of information concerning designs which have been prepared The purpose of this paper is to describe some of the newest designs of this kind which have been made and to explain some of their features more fully so that their merits may be intelligently considered by engineers who may be interested

The use of electric motors to propel ships may at first seem inappropriate since with such a method the power of steam must first be converted into mechanical work then into electricity and then again back into mechanical work All of these processes involve appreciable percentages of loss which seem to discourage the undertaking and it is only by the most careful scrutiny of all features that the relative desirability of such an undertaking can be ascertained Some of the important reasons for the adoption of electricity may however be suggested by the following comparative figures

	Revolutions per Minute	Weight Lbs per Horse-power	Rankine Efficiency
12 000 kw high speed turbine without generator	1800	8 5	1%
Group of Parsons marine turbines designed to give 28 000 horse power to four propeller shafts	320	12 0	
North Dakota turbines two each 12,000 horse power	300		50%

The large differences shown by these figures are incident to speed the ship turbine being very large extent of its application is still entirely problematical. In the case of electric propulsion no such uncertainty exists We have proved by application to other arts that certain results can be accomplished in a thoroughly reliable manner and the designs here discussed simply deal with cases comparable with the simplest and most direct uses of electric power on shore

The comparison of weights and efficiencies of turbines shown by the figures given above apply only to certain conditions and in other cases the comparison might be very different so that in such a problem every case must be considered on its merits and its merits cannot be judged until all features of design and operation are worked out in detail An idea of the requirements of ship propulsion may be given by the following rough statement of conditions

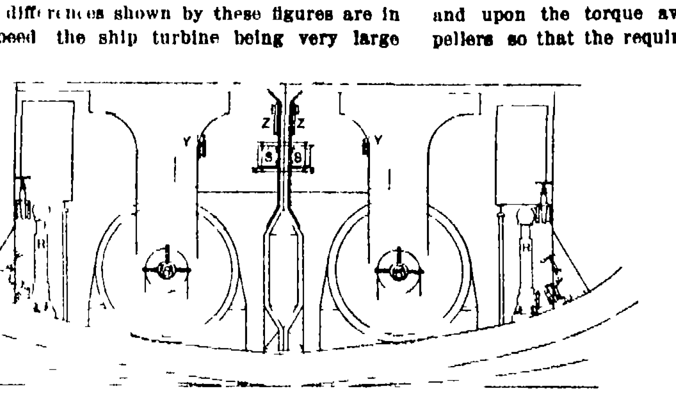
The power required varies approximately in proportion to the cube of the ship's speed The speed of revolution of shafts must be suited to the power delivered and the speed of the vessel if good efficiency is to be obtained There is much difference of opinion concerning the possible relations of propeller speed and efficiency The following figures gives an estimate of propulsive coefficients of a large battleship These figures are ascertained by comparison of several sources of information and should be considered only as a rough approximation.

In all vessels quick stopping and reversal is of great practical value and this quality is particularly valuable in warships The effectiveness of reversal is dependent both upon the area of propeller blades and upon the torque available for reversal of propellers so that the requirements of reversal afford an operate marine turbines at speeds below their best point of performance and consequently their efficiency falls off very rapidly with further diminutions of speed In an electrically propelled ship an excess speed condition can be adopted for the maximum revolutions so that the loss of efficiency with diminishing speeds is relatively less

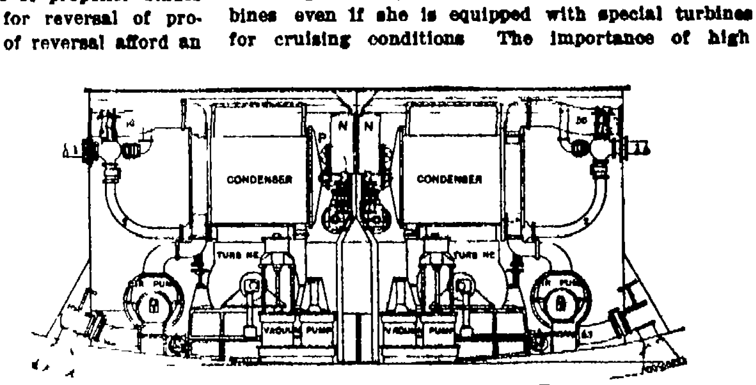
Propulsive Coefficients

Revolutions per Minute	Two Propellers
100	0 56
150	0 539
200	0 507
250	0 485
300	0 470

One of the important advantages of electric propulsion as compared with other possible methods of speed reduction lies in the fact that arrangements can be made by which the ratio of the reduction is changeable so that the turbine may be run at its most effective speed under more than one condition of the vessel's operation The possibility of such a change in speed ratio is particularly valuable in connection with warships since such vessels need very high speed for emergency conditions and also need to operate economically at low speed so that their radius of action may be made as wide as possible with a minimum dependence upon coaling stations. It will be seen that these qualities cannot well be combined in a ship whose propellers are driven directly by turbines even if she is equipped with special turbines for cruising conditions The importance of high



SECTION AT FRAME 104 LOOKING FORWARD



SECTION AT FRAME 89 LOOKING AFT

Turbine electric propelling apparatus installed in engine-room of battleship with all auxiliaries specified for direct turbine installation

complicated and expensive and relatively inefficient, while the high speed machine is very simple in construction small and highly efficient. It is therefore primarily for the sake of speed reduction that we turn to electricity as a propelling force.

It has also been proposed to use mechanical gearing for the same purpose, and something has already been accomplished in that direction The use of gearing for such a purpose is, however still practically undeveloped and the requirements are such that the additional reason for desiring low propeller speed the area of low speed propellers being larger the tendency to slip is diminished In some turbine ships, a good deal has been sacrificed for the sake of quickness of reversal and the qualities of different ships in this respect are very different. It may be said that with fairly large and low speed propellers, a reversing torque equal to 60 per cent of full load running torque will bring a ship up to the best standards of quickness in reversing

Since practical propeller speeds are always much slower than desirable for turbines, the tendency is to speed being much greater in turbines of small capacity than in large, the cruising turbines which require only a small capacity cannot be made efficient.

In this paper some specific information is given concerning two cases of electric propulsion designs One of these relates to the apparatus covered by a proposition recently made to the government for propelling machinery for Battleship No. 35 The other applies to the machinery covered by propositions recently submitted to shipbuilders for propelling machinery to be used in one of the government colliers recently authorized by Congress. The first [illegible]

* Presented at the Pittsfield-Schenectady mid-year convention of the American Institute of the Electrical Engineers, Feb. 1911. Copyright 1911, by A. I. E. E.

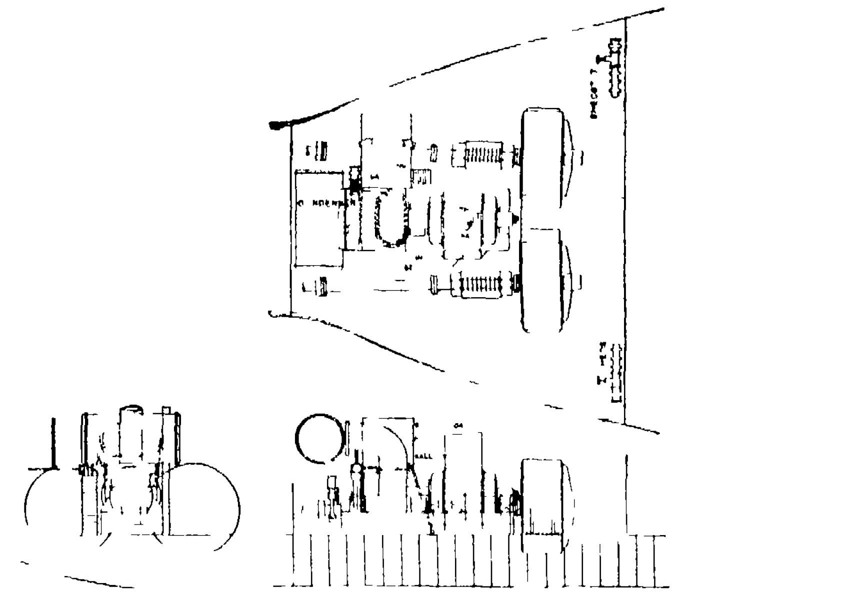
that of a high speed warship the arrangement has been made such that two ratios of speed reduction can be used, the change from one to the other being accomplished by changes of connection which accomplish a change in the number of poles of the propelling motor. In the second case no such pole changing is used, the ratio between turbine and propeller being fixed at all speeds.

In the battleship, two generating units and four motors are used so that an additional gain in economy can be effected at all speed by operating with one half of the apparatus in use. In the case of the collier there is only one generating unit and two motors so that all the apparatus is used at all speeds. In the case of the collier however the speed conditions are very favorable to the turbine and the speed efficiency curve is extremely flat as compared with that of turbines generally used for direct propulsion of ships.

DESIGN MADE FOR UNITED STATES BATTLESHIP NO. 35

The installation proposed for Battleship No. 35 is shown by the accompanying drawing which shows not only the electric generating and transmission apparatus but all the auxiliaries which are installed in the engine room in the government designs for direct turbine drive. The position of shafts and arrangement of engine room in this case is identically the same as that proposed by the government for direct drive by Curtis turbines. The apparatus is installed in two engine rooms separated by a water tight bulkhead. In each engine room would be installed one 12,000 kilowatt generating unit and two motors each having a capacity of about 7,000 horse-power. These two motors are coupled together into a single unit and connected to the propeller shaft. One of these motors is of the K type with squirrel-cage armature, the stator windings being so arranged that they can be connected either for 30 or for 50 poles, a suitable group of heavy toggle switches which effects this pole changing being carried by the frame of the motor itself. The other motor is of the M type with a definitely wound rotor connected to slip rings through which an external resistance can be inserted in series. These slip rings are short circuited by a very simple and effective sliding spring arrangement. When this short circuit is accomplished the external resistance is entirely cut out. This M motor is wound for 30 poles, and with its resistance cut out has exactly the same characteristics as the K motor when the latter is worked with its 30-pole connection.

The resistance used with the type M motor is for the purpose of affording the desired torque in reversing and these resistances constitute a very important feature of the proposed designs since under conditions of reversal they must absorb nearly the total electrical energy of the system. These resistances have been developed by careful experimenting and are capable of accomplishing the desired result in a very compact space and with very large factors of safety. They are made of non-corrosive material and the heat from the electrical energy dissipated is delivered to the sea water which freely circulates through the resistance compartments by convection. They are easily disconnected and taken apart, or if desirable renewed and will afford an entirely satisfactory solution of a problem which has sometimes been very embarrassing in large induction motor installations. The accompanying drawing shows the arrangement of these resistances in sufficient detail to be intelligible.

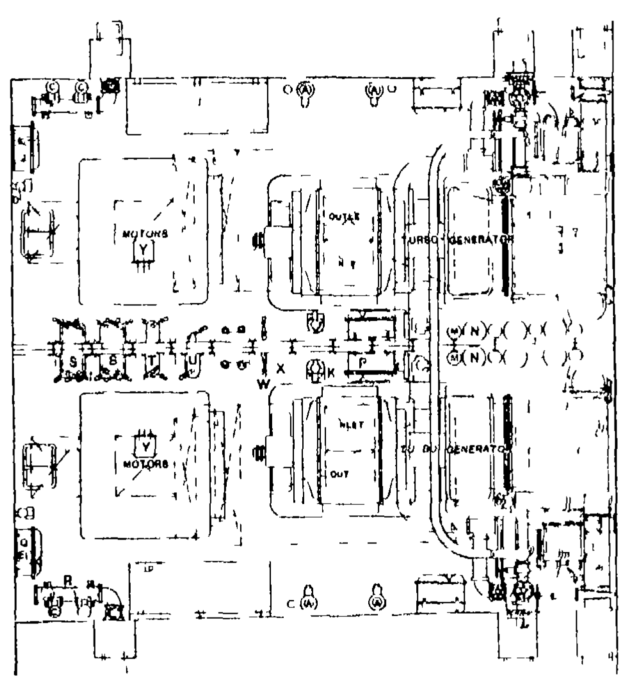


TURBINE ELECTRIC PROPELLING APPARATUS

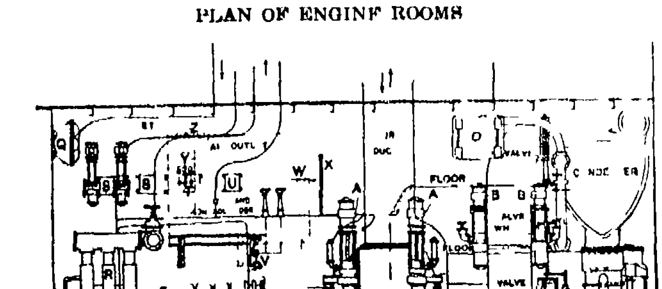
Installed in engine room of Collier with [illegible] the steam auxiliaries shown

The switching apparatus is so arranged that all switches can be worked from either engine room, the shafts being carried through bushings in the water tight bulkhead. When the ship is operated at high speed with both generating units the engine rooms will be operated separately but when the ship is operated from one generating unit it will be more convenient to control everything from one engine room and the switches are so arranged that this can be done, the position of every connection being visible and controllable from either side of the bulkhead. The accompanying tabulation and curve sheet shows the propeller speed, horse-power and water rate of turbines for every different speed of the ship and shows the apparatus which would normally be in use under each condition of speed.

The conditions for different speeds are those which will give the best economy and which would ordinarily be used for continuous operation at such speeds but it is possible to vary the speed of the ship up and down with any arrangement of motors by simply changing the steam admission to the turbines, the only limit being the safe speed and safe carrying capacity of the apparatus. Normally the ship would be operated at higher speeds with two generators and four motors all of the motors having the 30-pole connection. The turbine speed is then reduced in the ratio of 7.5 to 1, the generators having four poles. When the speed becomes sufficiently reduced improvement of economy can be effected by disconnecting one

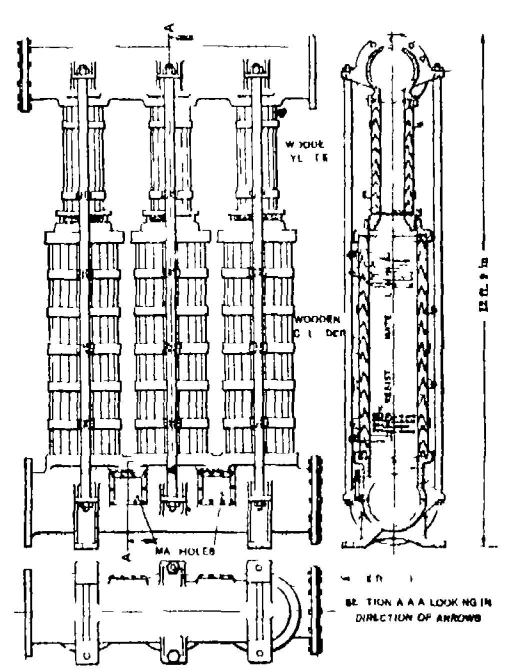


PLAN OF ENGINE ROOMS



ELEVATION OF STARBOARD MACHINERY LOOKING INBOARD

A, Main feed pumps; B, Fire and bilge pumps; C, Forced lubrication service pumps; D, Fuel oil pumps; E, Oil cooler circulating pumps; F, Pipe insulator circulating pumps; K, Auxiliary air pumps; L, Auxiliary circulating pumps; M, Air compressors; N, Compressed air tanks; O, Feed heaters; P, Auxiliary condensers; Q, Oil coolers; R, Water rheostat; S, Motor switches; T, Generator switches; U, Tie switch; V, Pole-changing switches; W, Hydraulic gear operating wheels; X, Liquid tachometer; Y, Field rheostat; Z, Switch panel.



GROUP OF RESISTANCES FOR 7,000-HORSE-POWER MOTOR FOR BATTLESHIP EQUIPMENT

of the generators and two of the motors as shown by the curve and when the speed had fallen sufficiently low a still further gain can be accomplished by connecting the remaining motors for 50 poles instead of 30 poles When this change is made the ratio of reduction is increased from 7 to 1 to 12 5 to 1 and a new cycle of favorable speed operation in the turbine is begun The economy in speeds between 12 and 14 knots is of vital importance in war ships and the very fine economy under these conditions afforded by this design will immensely increase the military value of a vessel so equipped

TABLE I

Steam conditions [illegible] lbs pressure vacuum 28 inches [illegible]0 deg F superheat

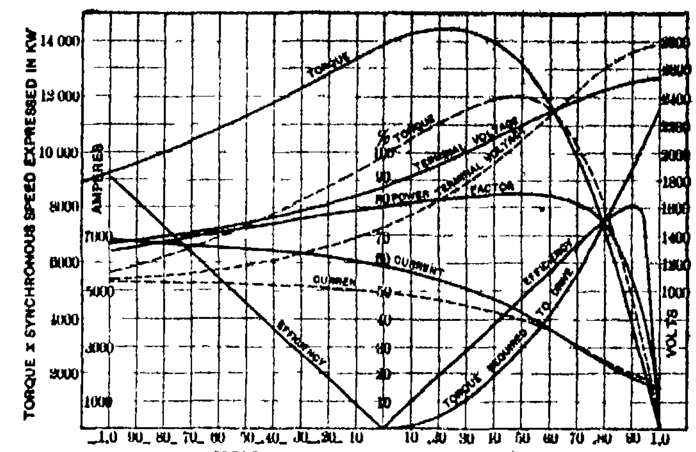
Knots	12	16	18	19	20	21
Motor r p m	87	11[illegible]	1[illegible]2	140	149	160
Generator r p m	1110	882	1010	1072	1140	1130
Shaft brake h p per [illegible]	1650	11100	16400	19400	22100	25000
Lbs Steam per shaft h p per hour	13 2	13 4	11 8	11 3	11 25	1[illegible] 3

Since the power required to propel a ship falls rapidly with diminished speed and since it is not necessary to maintain any fixed frequency voltage or degree of excitation the magnetic densities of the apparatus can be varied as the speed reduces so as to give the best efficiency consistent with the torque required With such an equipment the excitation could be derived either from an outside source or partly from an outside source and partly from a direct-coupled exciter In this case it is proposed to excite from an outside source the ship's regular circuit but this excitation can be varied by a rheostat so that the best possible electric efficiency is maintained

In the installation here described it is proposed to ventilate the apparatus by air from the upper deck One duct will convey air to each piece of apparatus and another will discharge it outside the engine room the apparatus being so designed as to impel the proper amount of air through these ducts In this and other cases of electric ship propulsion it might be desirable to ventilate the apparatus by drawing air through it by blowers and delivering the air so heated to the furnaces Such a process would effect appreciable economy and would probably be desirable It has not been considered in this case because there was not time to study the practicability of arrangements

In this battleship installation it is not proposed to make any changes of connection of circuits resistances or poles while the current is flowing Preliminary to all such operations the field switch will be opened The switches proposed are of the toggle type not designed to open under load and are arranged with electric locks so that they cannot be moved when the system is alive The turbines are arranged with speed governors of the ordinary type which are capable of closing any valves which may be open if the speed rises The number of valves which can be opened at any time is however governed by hand control and the speed governor is in capable of adding to the number so opened When the field circuit is interrupted the generating unit rises to its maximum speed and runs idle until the circuit is re-established In the meantime the desired connections are made and the field re-established whereupon the generator and motors resume the proper speed relation and proceed to accomplish the desired result

When these electrical conditions are considered it would simply be necessary to open the field circuit and change to the proper connection and the currents resulting from such wrong connections would not be harmful since the mistake would be apparent and soon corrected The case is therefore very different



BATTLESHIP NO 35

Conditions of combined operation of motors and generators and reversing resistance in circuit and generators at full speed Dotted lines show torque voltage and current when only one generator is used The power factors and electrical efficiencies are about the same with either one or two generators External resistance 0 207 ohm per phase rotor resistance 0 0069 ohm per phase

from that of an ordinary electric circuit where all sorts of needs must be provided for from a source of fixed potential and where the generating plant constitutes a battery capable of delivering power in indefinite quantities either for use or for destruction in the case of short circuits or wrong connections

The following is a list of the weights of the different parts of the installation proposed The aggregate weight of these parts is probably not much less than that of the turbines alone which would be used for direct propulsion The generating units in this case however include heavy cast iron bases and there would be a considerable saving on account of the supporting structures which would be used with turbines for direct propulsion The absence of any system of forced ventilation also increases the weights In other cases of battleship propulsion which have been studied considerable savings of weight have been effected and it is believed that with the best arrangements similar economies could be accomplished in this case

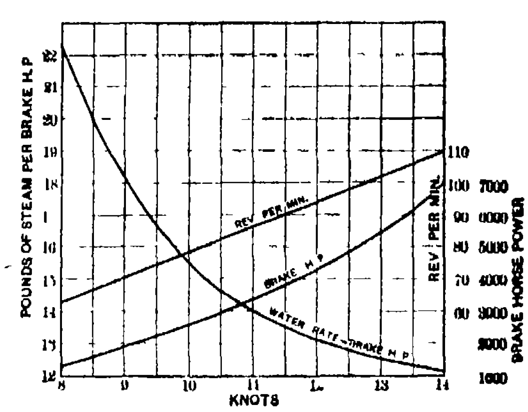
	Pounds
Two generating units	674 000
Accessories	2 600
Four motors	408 000
Switchboard and switches	5 000
Field rheostats	1 600
Water-cooled rheostats	6 000
Cables	17 800
Total weight	1 115 000

EQUIPMENT FOR NAVAL COLLIER

The installation proposed for a naval collier is similar in general principle but much simpler than that proposed for the battleship The requirements of this ship being to operate continuously for long periods at a speed near the maximum there is no particular need for high economy at lower speed and it therefore becomes desirable to simplify the apparatus as much as possible in the interest of lightness cheapness and good economy at the normal operating speed of the vessel which would be about 13 or 14 knots. In this case only one generating unit and two motors are used

Another difference between this case and that of the battleship is that it is proposed to use oil switches so that changes of connection can be made without the trouble of interrupting the field circuit. When the resistances are in circuit in the motors, [illegible] propeller could be reversed independently by [illegible] throwing the lever of an oil switch. This qualit[illegible] instantaneous reversal would be valuable in a shi[illegible] this kind since such large freighters steer very b[illegible] at low speeds so that it is very desirable to steer by the propellers in anchoring or docking

For this collier installation the method of ventilation proposed is somewhat different from that in the case of the battleship The generator would be ventilated in the same way by a duct from the deck above and another duct to take away the heated air In the case of the motors it is proposed to take the ventilating air from the engine room and deliver it to the suction of a blower which puts air into the Howden draft system of the after fire room This



PERFORMANCE CURVE ELECTRIC DRIVE UNITED STATES COLLIER

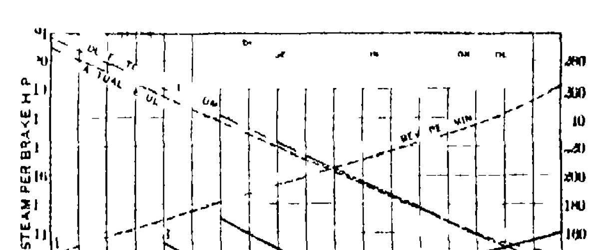
100 lb gage 0 deg fahr superheat 28½ in vacuum—displacement about 20 000 tons

would afford effective ventilation for the motors and about the right amount of ventilation in the engine room without the use of any other blowing apparatus

The accompanying curve sheet shows the steam consumption per shaft horse-power which would be required with this apparatus at different speeds of the vessel These results are susceptible of exact calculation since generating units and motors almost exactly similar to those proposed have been repeatedly tested It is very difficult to get at any accurate estimate of the steam consumption of such a ship when operated by reciprocating engines, but all comparisons which have been made indicate that the turbine electric apparatus would effect some economy in steam consumption although it is probable that the saving as compared with the best engine equipment would not be very large. The demand for electric propulsion on one of these colliers has come from the Navy Department through a desire to demonstrate the practicability of this method of propulsion The case is not particularly favorable to electric propulsion and should not be taken as a basis of comparison of the system with other methods Electric propulsion will make its best showing in vessels requiring a very large amount of power or vessels which require a good economy at low speeds as well as at high High-speed warships or very large moderate-speed liners afford the best fields for its application.

ELECTRIC CHARACTERISTICS

The accompanying curve sheets show the characteristics of the combined action of motors and generators proposed for these two installations. Two of these sheets show conditions of operation [illegible] with resistances in circuit and the other [illegible]

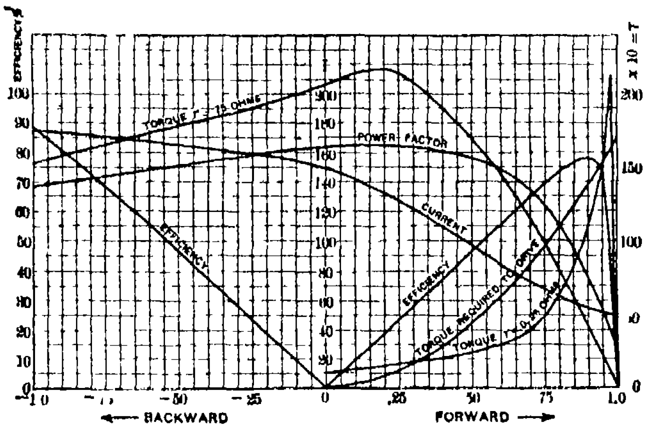


PERFORMANCE CURVE UNITED STATES BATTLESHIP NO 35

Pressure 20? lb gage [illegible]0 deg fahr superheat 28 in vacuum

will be seen that an immense advantage results from the fact that they are not bound to any fixed frequency or voltage The generator is designed simply to do the work required of it and it is incapable of delivering a current in excess of the safe carrying capacity of any conductor in the system No kind of wrong connections can result in any burn-out If a wrong connection should be made

conditions in the collier installation without resistance in the motor circuits and with the generator operated at various speeds. From these curves the torque available under any condition of operation and also the current, voltage and necessary excitation can be seen or readily estimated No curves are given to show the conditions of operation without resistance in the battleship installation because the character istics under such conditions are virtually the same as those in the collier and are sufficiently illustrated by the curves given in the case of the collier These curves shows the effect of different degrees of excita



UNITED STATES COLLIER

Showing conditions of combined action of generator and motors with reversing resistances in circuit and with generator at full speed External resistance 0 75 ohm per phase rotor resistance 0 025 ohm per phase

tion upon power factor and efficiency As a vessel so propelled is slowed down the excitation could be reduced in proportion to the propeller speed and the maximum degree of reduction in excitation will give the best electrical efficiency From the curves here given however the decline of excitation is less rapid than that of the speed this degree of diminution be ing chosen so as to give an ample margin of torque under all possible conditions of operation In prac tice whenever the ship is operated under any fixed condition of speed the excitation should be reduced to the lowest possible point necessary to maintain the required torque on the propeller Since the margin of torque assumed in the curves given is very ample the electric efficiencies would be even better than those indicated by the curves

In connection with this paper which gives specific information concerning two sets of designs the author has thought it desirable to give also some fig ures concerning other cases which have been studied with greater or less degrees of thoroughness in order that an idea may be formed regarding the relative desirability of such methods in connection with ships of different kinds The accompanying tabulation gives some such figures

TABLE II

Case.	Displacement, Tons.	Shaft, Horse-Power	Approx. Wt. Main Engines or Turbines Tons	Weight of Corresponding Electric Drive.	Speed Knots.	Revolutions per Minute, Electric Drive.	Water Rate Elec. Drive, Without Aux., lb per Shaft Horse power	Steam Conditions
1	19 360	6 850	335	185	14 0	110	12 0	200 lb gage 28 5 vac dry
2	25 000	12,500	411	237	16 0	110	11 5	200 lb gage 28 5 vac dry
3	20,000	3 400	436	374	12 0	87	12 85	250 lb gage 28 0 50° superheat
		1 800	436	374	20 0	148	11 5	260 lb gage 28 0 50 superheat
4	10,946	2,275	102	56	10 5	86	12 0	175 lb gage 28 0 dry
5	9 900	5 500		133	14 6	114	12 5	181 lb gage 28 0 dry

Some of these designs for apparatus to propel ships have been criticised on the ground that the weights of electric apparatus shown were small in comparison with weights of similar kinds of apparatus used on shore This is to some extent true first because the structural part of these devices has been designed with a view to economy of weight although the designers have not gone nearly as far in this direc tion as it would be possible to do, and secondly be cause this ship apparatus is rated on a maximum output basis, whereas apparatus for other purposes provides for overload There have been some further weight economies possible on account of the special conditions relating to the operation of such ap paratus A careful comparison with a number of cases where large apparatus of similar character has been installed on shore shows that on a basis of very reasonable temperature rise, the magnetic weights in all cases agree closely and that these electrical de signs are in every respect normal and conservative

A Few Odd Things

It is said that in a room in Pompeii which was buried by Vesuvius' ashes eighteen hundred years ago, the excavators broke into a room full of glass of many kinds window glass ground glass cut glass and many varieties of colored glass and the Romans claim that they got malleable glass from the Arabians

Pliny tells of Nero having a ring with a gem in it through which he looked at the gladiators to see them more clearly Evidently old Nero had a monocular opera glass Ruskin in one of his lectures to his students said Gentlemen we are the best chemists in the world No Englishman ever could doubt that but we cannot make such a scarlet as that and even if we could it would not last for twenty years yet this is five hundred years old Such a dye could cer tainly be warranted against fading

Copper Production and Copper Reserves

In his economic studies of the world's supplies of the principal metals Prof J A Kemp devotes a sp cial section to copper Speaking of this in *Science* he says

Greatly stimulated by the development of elec tricity in later years the production of copper has advanced by leaps and bounds At present the United States are the heaviest producers with Spain follow ing next but only yielding one-eighth as much The United States furnish over half the total In 1850 th United States yielded 728 tons in 1900 over 303 000 and in 1908 471 000 Meantime in 1850 the price of copper was about 30 cents per pound Its lowest point in recent years was nine cents in 1894 Its highest 25 cents was attained in 1907 We may each of us imagine the variation in the profits of a mining enterprise as between 11 cents a pound and 15 cents let alone 20 or 25 cents Mining costs smelting and freight charges show no such variation so that with rising prices profits greatly increase Indeed few of the metals have such ups and downs as does copper

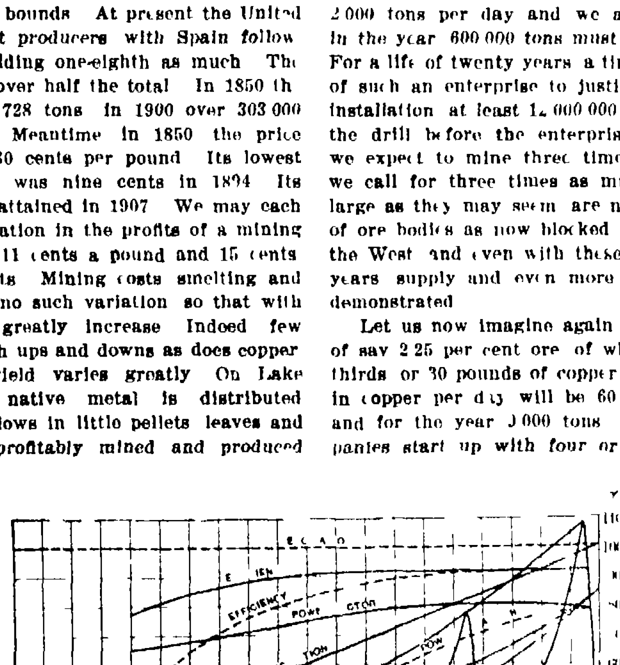
In its ores the yield varies greatly On Lake Superior where the native metal is distributed through ancient lava flows in little pellets leaves and sheets it has been profitably mined and produced through periods of years when it constituted but three-quarters of 1 per cent of the ore The general run is, however 1 per cent and above If we recall that in a ton of 2,000 pounds 1 per cent is 20 pounds and three-quarters of 1 per cent 15 pounds and if copper is selling at say 13 cents the mining manager must break down hoist concentrate with attendant losses, and smelt an ore worth less than $2 for all the metallic contents which it contains We can thus gain an idea of the close and economical work re quired and the ability demanded of a manager As the price rises the profits greatly increase, and tem porarily idle mines are brought within the widening remunerative zone and are quickened into life As the price falls the mines dangerously near the line close down and production ceases The lowest cost of production claimed is from the low grade and very large ore bodies of the West and is placed at or about 8 to 9 cents per pound laid down in New York

In copper ores outside of the Lake Superior region we usually find the metal in combination with sulphur The ores as they come from the mine may be rich enough to go directly to the smelter or they may require concentration before the grade is sufficiently high The ores which are directly smelted reach the minimum of copper in the boundary district of Brit ish Columbia but associated gold and silver raise the value per ton above $4 Copper ores yielding copper alone were smelted at Ducktown Tenn dur ing long campaigns at a little less than 2 5 per cent In earlier years and in many mining districts ores as high as 20 per cent were found rarely even higher but they in time were exhausted and 5 per cent would be quite rich for day in and day out averages

We can not predict copper with the certainty of iron It seldom appears in bedded deposits which can be measured In the deep mines we can not always see ahead for more than a year or two In some mines we know from exceptionally complete development of twenty years supply But the great advance in copper mining has been the entrance of relatively low grade ores into the productive field The wall rocks of ten years ago have become the ores of to-day Where we find in porphyries or schists copper sulphide disseminated in fine particles or as coatings along crevices and in sufficient richness to yield 2 to 2½ per cent throughout very large bodies it can be mined very cheaply and concentrated in enormous quantities so as to return a safe margin if the ore lies near the surface steam shovels make excavation extremely low in cost The huge pits and open cuts of this type of mine in the West are now among the great sights for the traveler Mills whose insatiable crushers take as much as eight or ten thousand tons per day are no longer unknown The drill blocks out the ore before mining begins and reserves can be estimated more closely than in the vein mines

If a mine is called upon to furnish a mill with 2 000 tons per day and we allow 300 working days in the year 600 000 tons must be supplied per annum For a life of twenty years a time practically demanded of such an enterprise to justify the great expense of installation at least 12 000 000 tons must be shown by the drill before the enterprise can safely begin If we expect to mine three times this amount per day we call for three times as much ore These figures large as they may seem are not beyond the estimates of ore bodies as now blocked out in several places in the West and even with these great demands twenty years supply and even more in instances have been demonstrated

Let us now imagine again a 2 000-ton daily output of say 2 25 per cent ore of which the mill saves two-thirds or 30 pounds of copper in the ton The output in copper per day will be 60 000 pounds or 30 tons and for the year 9 000 tons Should three new com panies start up with four or five times this output



UNITED STATES COLLIER

Showing condition of combination of generator and motors with varying speed of generating unit and with no external resistance in rotor circuit Dotted lines refer to constant full load excitation Full lines refer to variable excitation Torque curves for motor are given separately for different fixed generator speeds All other curves apply to normal condition where speeds of motors and generators vary together

16 000 to 4 000 tons will be added to a yearly supply which in 1909 was 5 2 168 tons We see great need of a growing demand in order that these vast con tributions may be absorbed

How long will our copper hold out? For the im mediate future there will certainly be no scarcity Copper does not oxidise as readily as iron and is not lost The world's stock steadily accumulates But twenty years is not a long look ahead Are there new countries which will be producers? Some old mines in Europe are no longer sources of the metal

"We do know of possibilities in Alaska that will

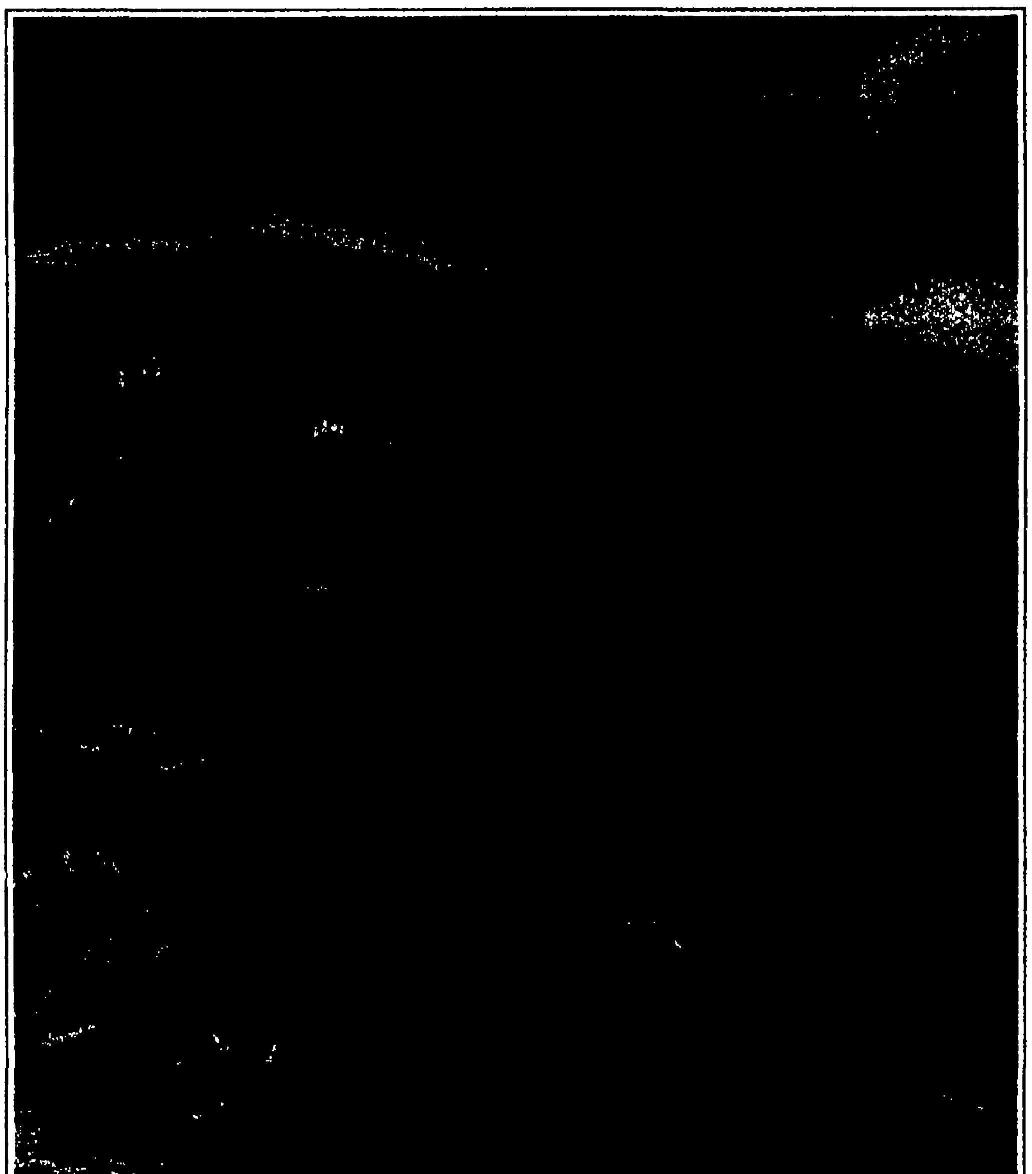
add some contributions We know of new or recently opened ore bodies in Peru Bolivia and Chile that promise well We hear of very large deposits in the southeastern corner of the Congo State once worked by the ancients now revived by the moderns, and possessing large reserves of 15 per cent copper ore The Cape to Cairo Railway will give them great impetus For the immediate future there is no lack, but if we look fifty years or a century ahead we can speak with less confidence. In a general way we may say that probably new discoveries will, for a time at least, more than keep pace with demands. But when we look fifty years into the future we are not so certain It behooves the producers to use no treatment of an ore except a careful and economical one. If tailings and waste from our mills now contain one-third the copper in the original ore, they should be impounded and kept from being washed away by floods, against the possible call of the future. We dare not say that they will never be within the range of profitable treatment, even though their low percentage places the copper beyond reach to-day The copper situation is not one to excite anxiety, yet it is also one not to encourage extravagance."

The New Rigid Dirigible of the English Navy "N I"

A Giant Airship of Novel Construction

By Carl Dienstbach

THE Zeppelin Airship Construction Company has always firmly refused to build any airships for foreign countries on the ground that its plant is virtually a gift and a trust of the German nation that contributed nearly $2 000 000 to Count Zeppelin's enterprise and that therefore none of the experiences and facilities of the Zeppelin dockyard should inure to the benefit of foreign governments



By Courtesy of the Illustrated London News.

THE BRITISH NAVAL AIRSHIP N I THE FIRST DIRIGIBLE BUILT FOR THE ENGLISH NAVY

In England the authorities have been so severely criticised for trifling with the serious question of an aerial navy and merely building a series of pygmy military dirigibles for experimenting and training purposes that the English people bought by subscription the two latest and best French airships the big Clement Bayard II and the new gigantic Lebaudy, and presented them to the government Patriotic and welcome though this action was it may be said to have been inspired by a popular misunderstanding of the government's policy For England the first necessity is a naval dirigible An airship that must be capable of hovering over the channel fleet's field of action and follow the home fleet far out into the North Sea had not yet been developed abroad nor could it be created over night Endurance staunchness, economy of fuel at high speed insensibility to weather and sun were the qualities most desired. The authorities were soon aware that the type perfected by Count Zeppelin and his engineers and pilots came nearest to meeting these requirements, but all endeavors to profit directly from the priceless experience and skill acquired by the Count and his staff during nearly a decade of painstaking labor met with a flat refusal Nothing remained but to make the experiment unaided and it must be conceded that the English have approached this task with a deliberateness and thoroughness worthy of its importance What it really meant may be gathered from the failure of the Schütte-Lanz giant rigid dirigible whose wooden frame cost hundreds of thousands and finally became far too heavy In England a colossal revolving arm or whirling table was erected at great expense for the sole purpose of testing the naval airship's propellers under the conditions that prevail in actual flight, and for developing the most economical type

The English N I as the new aerial dreadnought is called has just been completed after remaining on the stocks for nearly three years From the "Zeppelins so far built it differs in the displacement, which exceeds even the big Deutschland's by fully 1 000 cubic meters, being 20 000 instead of 19 000 The length is 510 feet instead of the "Deutschland's" 485½ and the beam 46 feet. Instead of aluminium the new lighter and stronger alloy, duralumin, has been used in the hull

A noteworthy innovation is found in the engine room. Reliability of the propelling machinery of airships was for a time sought in multiplying the motor units "Deutschland and Z VI had three motors, the new Krell I has four motors Most recently this tendency has undergone a temporary change. It is now the fashion to install more powerful units, engines that are to all intents and purposes identical with those of the 'big gasoliners of the ocean and like them are not much given to breaking down Thus the new German military airship M IV is driven by only two engines but each of 200 horse-power and the English N I built more for endurance than extreme speed over water has also two 200 horse-power motors for its greater displacement In the M IV" these motors have each six cylinders and are very heavy the engines of "N I have eight cylinders each and are built by the firm of Wolseley of heavy gasoline traction frame As Count Zeppelin's Deutschland developed a speed of nearly 38 miles an hour with three motors of 115 horse-power each the N I that has finer lines at the stern is expected to make 43 miles an hour with 55 horse-power more and only 1 000 cubic meters more displacement—which results solely from increase in length not of beam

In still larger airships there will be again multiplication of motor units—to distribute the load—but each motor being of 200 horse power sufficient reliability will also be guaranteed in the single unit The N I is equipped with powerful apparatus for wireless telegraphy

Copying Process for Printed Matter and Manuscripts

A NEW method for photographic printing was presented to the Académie des Sciences by M De Fontenay and it is likely to be of great service in some kinds of work It is used in reproducing any sort of printed matter or manuscript such as pages of books or engravings letters etc and these may be even printed or written on both sides He uses an ordinary printing frame and places in it first a sensitive photographic plate with the glass side outwards and then the printed page in contact with the emulsion This is exposed to light in order to make the print The black parts of the page absorb nearly all of the light and on the contrary the white portions diffuse the light and reflect it upon the corresponding parts of the sensitive layer After developing the plate we have a negative somewhat similar to that which would be given by making a print by transparence in the usual way The new method exposes the whole of the photographic plate and the printed page lies back of it so that the process would seem paradoxical at first, and it would appear that the plate should be fogged This is not so as is proved by its development Any ordinary developer will answer It is found that the exposure should be made by red light and green or yellow light also gives good results but blue and violet do not succeed Slow plates appear to be the best and even photographic paper could be used, were it not for the fact that the grain of the paper is apt to spoil the effect. The new method is likely to prove of value It will render great service where a copy is to be made strictly like the original with opaque sheets or those having printing on both sides, including book text, engravings, figures bound in a book, parts of maps, and the like. Such are generally copied by the camera, but this is often cumbersome and cannot be used in all libraries. It is also difficult to make a copy in full size, not considering the distortions given by the lens. At present we are able to make copies in any library where darkness can be obtained for a short time so as to allow of putting in the plate, and such copies are very exact. A printing frame is not indispensable, and the sheet can even be applied by the hand. All the outfit that is needed is a few plates and a box of matches, or better, a pocket electric lamp. The archaeologist or other worker when traveling and not having a camera at hand can thus very easily secure copies of valuable documents.

Demolishing a Reinforced Concrete Building

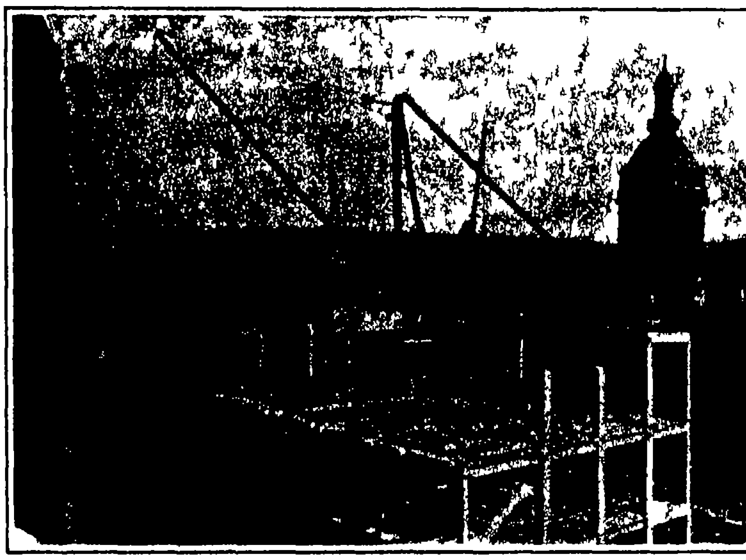
Steel Rods in Reinforced Concrete do Not Rust

The illustrations show a number of views of the operations in progress in the demolition of a seven story reinforced concrete building at Baltimore. This structure was erected shortly after the great fire of 1904 and is consequently comparatively new, and built on the modern lines of this type of construction. The massiveness of the building which was regarded as fireproof, is shown by the fact that some of the larger pillars and girders in the framework weigh no less than one ton to each linear foot. These are 3 feet in thickness and 5 feet in width and one of the main girders supporting the upper framework is no less than 49 feet long. It is reinforced with 42 steel rods extending entirely through the concrete. Twenty-six of these rods are 2 inches in diameter and sixteen 2½ in diameter. In some parts the thickness of the reinforcement is as much as 3 inches. The total weight of the concrete in the building is estimated at nearly 8000 tons not counting brick used in partitions and elsewhere. The floors are of a layer of concrete 2 inches thick set into a mesh of ¼ inch steel wire while the stairways are molded of concrete blocks.

This seven story building which has been utilized for newspaper publication is to be replaced by a sixteen story office building and every part even to the foundation must be removed. A contract has been concluded to demolish the building in 90 days. Work was commenced in March and is progressing so rapidly in spite of the great weight that must be removed and the difficulty of severing the heavy framework into sections for removal that during April fully 75 per cent of the building had been torn out and turned into concrete ballast for railways and into scrap steel.

The system employed is notable for its time and labor saving features. Beginning at the top the roof members had to be cut and burned into sections that could be readily lifted by a boom derrick and lowered by block and tackle to wagons in the street to be hauled away. As much of the concrete work averages 7 tons in weight for a length of 6 feet, the majority of the posts, girders and other material have been separated into this size. The first process is to cut through the concrete. This is done by compressed air hand drills operating at a pressure of 125 pounds to the square inch. The steel point bores into the material making an opening varying from 6 inches to a foot in width, so that very little debris results. The tool is guided between the steel rods removing all the concrete until they are completely exposed in the concrete fissure.

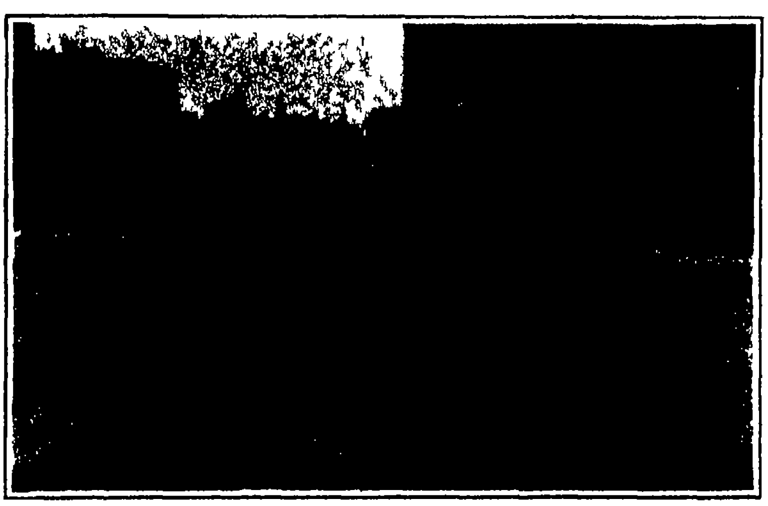
The steel is not cut by saw or chisel, but severed by corroding heat. A Linde compressed air coal gas burner is used. Portable reservoirs are filled with gas at a pressure of 1,[illegible] pounds. The burner is connected with tubes for conveying the gas, also oxygen. The flame composed of these elements develops a heat of fully 2 000 degrees. The burner is pressed against the rod until the latter becomes red hot. Then the oxygen is applied to the metal and corrodes it, so that it becomes honeycombed. As the flame is small in dimensions less than a half inch of the metal is removed in severing the rod. How rapidly the work is done appears from tests made on the Baltimore building which show that one man can with the burner do as much as eleven men with saw or chisel in the same time.



THE BOOM DERRICK USED FOR LOWERING THE MATERIALS TO THE WAGONS

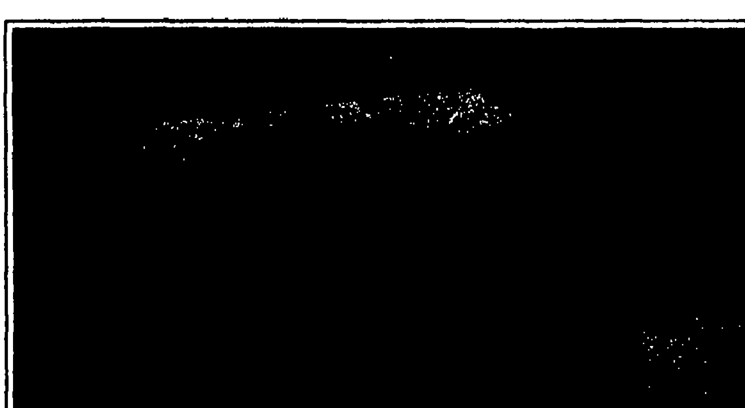
In removing the concrete sections two boom derricks are used. The boom of one is 60 feet long and from it extends a block and tackle of a capacity to handle any weight which is to be conveyed. When a piece of girder or pillar is ready to be taken out the end of the boom is swung over it in the usual manner, and the load clamped by chains, when it swings out and down into the wagon. The pieces are taken to a dump yard near a railroad track where a skull cracker having a drop of 60 feet and a weight of 2 000 pounds crushes the concrete into fragments. It is then loaded on cars for ballasting and the steel is sent to the mill for rerolling.

Considering the operations performed in the work of demolishing the power plant is comparatively small. The compressed air is supplied by two compressors of 30 horse power each. The air is forced through iron piping laid in the building and tapped at several different points with wire-wound flexible hose. Thus the drills are operated for cutting the concrete. An equipment of 40 drills is installed but 25 have been found sufficient to do the work, the others being held in reserve in case of a tool breaking or becoming dull. The burners are connected with metal tanks which one man can carry from place to place, but the tubes connecting the tank with the burner are long enough to allow the operator to separate the metal of a half-dozen sections or more before moving the reservoirs. After the concrete has been cut out there is no time lost. As the air tool finishes its work the burner takes its place and such is the rapidity of the action that the largest concrete form may be severed in two places, lifted out by the derrick and lowered into the wagon in less than a half hour. The wrecking of the News Building means a loss of nearly $300 000, its cost for construction. The only salvage is the value of the concrete ballast and what the mill pays for the steel which is classified as scrap. The work is an illustration of how modern enterprise does not hesitate to sacrifice property where its increase in business requires greater facilities for operation.



COMPRESSED-AIR DRILL CUTTING THROUGH A GIRDER THREE FEET THICK

CUTTING THE STEEL RODS WITH THE OXYGEN BURNER



LOWERING EIGHT TONS OF CONCRETE AND STEEL TO THE STREET

DEMOLISHING A REINFORCED CONCRETE BUILDING

The South Sea Swells

Every reader of books of travel will remember with what frequency in the old narratives of experiences in the South Seas reference is made to the heavy swells of the ocean which impressed the navigators with the idea of their remoteness from land.

The great size of the sea waves in high southern latitudes has been explained by the fact that south of the Cape of Good Hope and Cape Horn there is neither windward nor leeward shore and the prevailing wind in all longitudes is westerly. Thus when a west wind springs up it finds a long westerly swell the effect of a previous wind still running. The new born wind increases the steepness of this swell and so forms majestic storm waves which sometimes attain a length of twelve hundred feet from crest to crest. The average height attained by sea waves in feet is about half the velocity of the wind in miles per hour.

Research as a Financial Asset*

The Money Value of Pure Science

By Willis R Whitney

Director Research Laboratory General Electric Company Schenectady, N Y

It is only in our century that there could be much significance to such a title as Research as a Financial Asset This is an industrial century and whether we are proud of it or not we are an industrial people For some reasons it may be thought unfortunate that so large a proportion of man's energies should be devoted solely to the industries In some eras we find that there was a predominance of art over industry in others literature was predominant in still others war and conquest Once territorial discovery and acquisition predominated and now in our own times the principles of community interest have so greatly developed that we are accustomed to seeing many people who instead of directly producing their own necessities of life are more generally repeatedly producing some one little article which contributes in the lives of others This we recognize as a natural tendency to higher efficiency Our intricate and delicately balanced system of work is becoming continually more complex but is certainly still covered by the elemental laws of demand and of survival New discoveries in our day are largely mental instead of geographical and the old battles of conquest have become wars with ignorance They are struggles to overcome inefficiencies attempts to broaden the common mental horizon as our ancestors broadened their physical horizon Very few people realize the rapidity with which technical advances are being made Few realize how the way of this advance has itself advanced I might make this more clear by an illustration

Consider for a moment the increasing uses of chemical elements and compounds New combinations in alloys medicines dyes foods etc and new uses and new materials are being produced daily For a more simple comparison consider only the advances in technical uses of the metallic elements

Copper iron and five other metals were known and used at the time of Christ In the first 1800 or 1900 years of our era there were added to the list of metals in technical use (pure or alloyed) about eight more or a rate below three a century There has been so much industrial advance made within the past twenty or thirty years that fourteen new metals have been brought into commercial use within this period This is almost as many in our quarter century as in the total preceding age of the world Of course this rate as applied to metals apparently cannot continue but there is no reason to question the possibility of the general advance it indicates For centuries a single metal was made to serve for all uses which that metal could fill Then two metals divided the field each being used where it was preferred for any reason Alloys began to displace metals to a limited extent While the engineer still uses iron for his railroad iron for his buildings and iron for his tools these irons are different and have been specially developed for those uses The electrical engineer prefers copper for his conductor certain irons for the frames of apparatus other special irons and steels for the shafts the magnetic fields etc and the specialization to best meet specific wants is still under way I suppose that this kind of complex development is largely responsible for research laboratories

A research laboratory is a place where men are especially occupied with new problems presumably not too far in advance of technical application By this group devoting its entire attention to the difficulties of realizing already well defined necessities or of newly defining and realizing together the efficiency of these processes is increased Men specially trained for this very purpose are employed and they are usually just as unfitted for successfully manufacturing as those who efficiently reproduce are of discovering or inventing It is merely an extension of the principle of the maximum efficiency A man with his entire attention devoted for months or years at a time to the difficulties of a single problem should be better able to reach a solution than the man who can devote only irregular intervals to it He should then also be the better prepared for a second problem

A research laboratory is also a place equipped with apparatus especially designed for experimental work In a busy manufacturing plant if a foreman has an idea pointing toward an improvement of his product he frequently has great difficulty in finding the time the necessary idle apparatus the raw materials and the incentive to try it In the laboratory all of these are combined and there is added a system of co-operation of permanently recording results and an atmosphere of research

The mathematics of co-operation of men and tools is interesting in this connection Separated men trying their individual experiments contribute in proportion to their numbers and their work may be called mathematically additive The effect of a single piece of apparatus given to one man is also additive only but when a group of men are co-operating as distinct from merely operating their work rises with some higher power of the number than the first power It approaches the square for two men and the cube for three Two men co-operating with two different and special pieces of apparatus say a special furnace and a pyrometer or an hydraulic press and new chemical substances are more powerful than their arithmetical sum These facts doubtless assist as assets of a research laboratory

When a central organization such as a laboratory has access to all parts of a large manufacturing plant and is forced sooner or later to come into contact with the various processes and problems the various possibilities and appliances it can hardly fail to apply in some degree the above law of powers

As a possible means of illustrating the almost certain assistance which one part of a manufacturing plant may give another when they are connected by experimenting departments or research laboratories and how one thread of work starts another I will briefly review part of a single fairly connected line of work in our laboratory In 1901 the meter department wanted electrically conducting rods of a million ohms resistance These were to be one-quarter inch diameter by one inch length In connection with this work we had to become fairly familiar with published attempts at making any type of such high resistances. Some kind of porcelain body containing a very little conducting material seemed a fair starting formula after the resistance of almost all kinds of materials had been considered Our own porcelain department was of great help in showing us how to get a good start We learned how and what to mix to get a fair porcelain and we found that small quantities of carborundum or of graphite would give us the desired resistance about once in a hundred trials The rods could be made but the variation of their resistance when taken from the porcelain kiln and when they were made as nearly alike as we could make them was often so many thousand fold that something new had to be done to make a practical success A small electric furnace was then devised for baking the rods and this was so arranged that the rate of rise of temperature the maximum temperature reached and the duration of heat at any temperature were under control and were also recorded The desired result was obtained and this work was thus finished It gave us a certain stock of knowledge and assurance

At that time a very similar problem was bothering one of the engineering departments Lightning arrester rods part of the apparatus for protecting power lines from lightning were needed Their dimensions were $\frac{3}{4} \times 6$ inches and they needed to have a definite but in this case *low* resistance and could apparently not be baked in a porcelain kiln The necessary variations in such a kiln are so great that in practice many thousand rods were repeatedly fired and afterward tested to yield a few hundred of satisfactory product All the cost of making an entire batch would have to be charged against the few units which might be found satisfactory and in many cases there were none good in a thousand tested It was evident that regulation and control of temperature was necessary This was found to be impracticable in case any considerable number were to be fired at one time as the heated mass was so great that the rods near the walls of the retort received a very different heat treatment from those near the middle and were consequently electrically different. This was still the case even when electrically heated muffles were used This difficulty led to experiments along the line of a heated pipe through which the rods could be automatically passed Some time was spent in trying to make a practical furnace out of a length of ordinary iron pipe which was so arranged as to carry enough electric current to be heated to the proper baking temperature Troubles here with oxidation of the iron finally led to substitution of carbon pipes. This resulted in a carbon tube furnace, which is merely a collection of 6-foot carbon pipes embedded in coke powder to prevent combustion and held at the ends in water-cooled copper clamps, which introduce the electric current By control of this current the temperature could be kept constant at any point desired. When this was combined with a constant rate of mechanical feed of the air-dried rods of porcelain mixture a good product was obtained For the past seven years this furnace has turned out all the arrester rods the number produced the last year being over 100 000 units

In this work we were also forced to get into close touch with the electroplating department. The rods had to be copper plated at the ends to insure good electrical contact The simple plating was not enough This introduced other problems which I will pass over as I wish to follow the line of continuous experiment brought about in part at least, by a single investigation The electric furnace consisting of the carbon tube packed in coke was a good tool for other work and among other things we heated the carbon filaments for incandescent lamps in it We were actuated by a theory that the high temperature thus obtainable would benefit the filament by removal of ash ingredients which we knew the ordinary firing methods left there While these were removed, the results did not prove the correctness of the theory but rather the usefulness of trying experiments It was found by experiment that the graphite coat on the ordinary lamp filament was so completely changed as to permit of a hundred per cent increase in the lamp life or of a twenty per cent increase in the efficiency of the lamp for the same life so that for the past four or five years a large part of the carbon lamps made in this country have been of this improved type This is the metallised or Gem lamp Naturally this work started a great deal of other work along the lines of incandescent lamp improvement At no time has such work been stopped but in addition to it, the new lines of metallic filament lamps were taken up In fact, during the past five or six years a very large proportion of our entire work has been done along the line of metallic tungsten incandescent lamps In this way we have been able to keep in the van of this line of manufacture The carbon tube furnace has been elaborated for other purposes so as to cover the action under high pressures and *in vacuo* Particularly in the latter case a great deal of experimental work has been carried out contributing to work such as that connected with rare metals In such a furnace materials which react with gases have been studied to advantage. Our experience with the metallised graphite led to production of a special carbon for contact surfaces in railway signal devices where ordinary carbon was inferior and suggested the possibility of our contributing to improvements in carbon motor generator brushes On the basis of our previous experience and by using the usual factory methods, we became acquainted with the difficulties in producing carbon and graphite motor brushes with the reliability and regularity demanded by the motor art.

Furnace firing was a prime difficulty Here again we resorted to special electrically heated muffles, where the temperatures even below redness could be carefully controlled and automatically recorded. This care aided by much experimentation along the line of composition of proportionality between the several kinds of carbon in the brush etc put us into shape to make really superior brushes. The company has now been manufacturing these for a couple of years, with especial reference to particularly severe requirements such as railway motors In such cases the question of selling price is so secondary that we can and do charge liberally for delicacy and care of operation in the manufacture

This carbon work naturally led to other applications of the identical processes or materials Circuit breakers, for example, are now equipped with a specially hard carbon contact, made somewhat as motor brushes are made

It is not my intention to connect all of the laboratory work to the thread which seemed to connect these particular pieces of work, but rather to show the possible effect in accumulating in a laboratory experiences which should show on an inventory.

Among other considerations which appeal to me is one which may be worth pointing out. Probably almost every manufacturing plant develops among its workmen from time to time [illegible]

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*Presented before the [illegible] of Technology on the Fiftieth Anniversary of the Granting of the Charter of the Massachusetts Institute of Technology

[illegible] They are usually the inventors of the company They are often discovered in spite of opposition They are always trying new things. They are almost of necessity somewhat inefficient in the routine production. In many plants they are merely endured, in a few they are encouraged In my mind their proper utilization is a safe investment. A research laboratory assists in such a scheme Sooner or later such a laboratory becomes acquainted with this type of men in a plant and helps them in the development of their ideas.

It is not a perfectly simple matter to measure the value of a research laboratory at any one time In the minds of some, the proper estimate is based on the money already earned through its work which otherwise would not have been earned by the company This is a fair and conservative method which in our corporation ought to be satisfactory when applied not too early to the laboratories. It does not take into account what we may call the good will and inventory value, both of which should be more rapidly augmenting than any other part of a plant The experience and knowledge accumulated in a general research laboratory is a positive quantity In our own case we expended in the first year not far from $10 000 and had little more than expectations to show for it Our expenses rapidly rose and our tangible assets began to accrue Perhaps I can point to no better criterion of the value of a research laboratory to our company than the fact that its force was rapidly increased by a company which cannot be particularly interested in purely academic work Our annual expenditures passed the $100 000 mark several years ago My own estimate of the value would probably be greater than that of others for I am firmly convinced that proper scientific research is demanded by the existing conditions of our technical age

Without going into exact values which are always difficult to determine consider for a moment the changes which incandescent lighting has witnessed in the past ten years In this field our laboratory has been active in contributing to both carbon and to metallic filaments Moreover all of the improvements in this field have been the product of research laboratories of trained men In the case of our metallized carbon filament which has now been in use several years, the efficiency of the light was increased by about twenty per cent Among the carbon lamps of last year these were sold to the extent of over a million dollars

A broader but perhaps less accurate impression of changes recently produced may be gained by considering the economy now possible on the basis of our present incandescent lamp purchases in this country and that which would have resulted if the lamps of only ten years ago were used in their stead On the assumption that the present rate of lamp consumption is equivalent to about 80 000 000 25 watt tungsten lamps per year and on the basis of one and a quarter watts per candle power as against 3 1 of the earlier lamps and charging power at 10 cents per kilo watt hour we get as a result a saving of $240 000 000 per year or two-thirds million per day Naturally this is a saving which is to be distributed among producers, consumers and others but illustrates very well the possibilities It is interesting to note that we are still very far removed from a perfect incandescent illuminant when considered from the point of view of maximum theoretical light efficiency

I see from advertisements that 65 000 of the magnetite arc lamps originally a product of the laboratory are now in use These must have been sold for something near $2 000 000 The supplying of electrodes which we make and which are consumed in these lamps should amount to about $60 000 per year

Our study of the properties of the mercury arc produced our rectifier which has been commercially developed within the past few years Of these about 6 000 have been sold As they sell for not far from $200 per set it is safe to say that this also represents a sale of over a million dollars The advantage of these outfits over other available apparatus must also be recognized as not far from $200 for each hour through which those already sold are all operating

In such a complex field as insulations and molded materials there have been many changes produced As far back as 1906 we were using annually in a certain apparatus 20 000 specially drilled and machined soapstone plates which cost $1 10 each As the result of experiments on substitutes for such material it was found that they could be molded by us in the proper shape, with holes in place and of a material giving increased toughness at a greatly reduced cost As the result of this fact the price of the purchased material was reduced to us from $1 10 to 60 cents which in itself would have paid for the work But further developments proved that the new molded material could be made for 30 cents, which the foreign material could not equal, so we have since produced it ourselves. This caused a saving of approximately [illegible] annually for this one molded piece I have heard of other cases where prices to us have gone down, when we have obtained a little promise from our experimental researches

In considering the research laboratory as a financial asset there is another view which might not be visible at first sight. It is the question of the difference between the value of the useful discovery when purchased from competitors in the business and when made by one's own company It is not usually pleasant to have to purchase inventions after their value is known, no matter from whom but to have to pay a competitor for such a discovery is doubly irksome. One is naturally unduly fearful of its value to the competitor and he in turn is overestimating another's power to use it. The purchaser's profit is apparently limited to the differences between his efficiency of operating it and that of the original owner A business usually comprises processes of making and selling something at a profit and study of the making of the most modern most improved most efficient is about as essential as the study of the limits of safe business credits

I was recently informed by an officer of another large manufacturing company where much chemical work is done and which established a research laboratory several years ago that the most important value they got from their laboratory was the assurance that they were keeping ahead and are at least prepared for the new if they cannot always invent it themselves Incidentally he said that from one part of their research work they had produced processes etc which had saved $800 000 a year They are at present spending in their several research departments a total of about $300 000 a year

We hear frequent reference to the German research laboratories and a brief discussion may be in place For the past fifty years that country has been advancing industrially beyond other countries Not by newly opened territories new railroads new farm lands new water power sites but by new technical discoveries In fact this advance may be said to be largely traceable to their apparent over production of research men by well fitted universities and technical schools Every year a few hundred new doctors of science and philosophy were thrown on the market Most of them had been well trained to think and to experiment to work hard and to expect little The chemical manufactories began to be filled with this product and it overflowed into every other calling in Germany These well educated young men became the teachers the assistants and the professors of all the schools of the country They worked for $300 to $500 per year They were satisfied so long as they could experiment and study the laws of nature because of the interest in these laws instilled into them by splendid teachers This condition soon began to make itself manifest in the new making of things—all sorts of chemical compounds all kinds of physical and electrical devices I might say that pure organic chemistry at this time was academically most interesting Its laws were entrancing to the enthusiastic chemist and consequently very many more doctors were turned out who wrote organic theses than any other kind What more natural than that organic chemistry should have been the first to feel the stimulus? Hundreds and even thousands of new commercial organic products are to be credited to these men and to that time All the modern dye stuffs are in this class Did Germany alone possess the raw material for this line? No England and America had as much of that But Germany had the prepared men and made the start

It seems to me that America had made a start in preparing men for the research work of its industries For example it is no longer necessary to go abroad to get the particular training in physical chemistry and electro-chemistry which a few years ago was considered desirable Advanced teaching of science is little if any more advanced in Germany to-day than it is in this country In my opinion the quality of our research laboratories will improve as the supply of home trained men increases and that the laboratories of this kind will be increasingly valuable when analyzed as financial assets I am certain too that the industries will not be slow in recognizing the growing value of such assets They merely want to be shown

Probably in most industries there are what I may call spots particularly vulnerable to research For example, the efficiency of steam boilers based upon the heat energy of the coal used and the efficiency of the engine using the steam is continually being raised We may expect until the maximum calculable efficiency is reached that this advance will continue The reason is not far to seek It is a vulnerable spot Improvement is possible A small increase in efficiency of a power plant is an ever-continuing profit Great numbers of steam power plants exist and so inventors are influenced by the fact that new improvements may result in enormous total economies Every rule of the game encourages them I can make this clearer by illustrations

Artificial light is still produced at frightfully poor efficiency Electric light from incandescent lamps has been greatly improved in this respect, but there is still room for greater economies It is still a vulnerable spot.

In the case of iron used in transformers we have another such vulnerable spot A transformer is practically a mass of sheet iron wound about with copper wire The current must be carried around the iron a certain number of times and the copper is chosen because it does the work most economically No more suitable material than copper seems immediately probable nor is there any very promising way of increasing its efficiency but in the iron about which it is wound there is a vulnerable spot The size of the iron about which the copper is wound may possibly be still much further reducible by improvements in its quality In other words we do not yet know what determines the magnetic permeability or the hysteresis of the iron and yet we do know that it has been greatly improved in the past few years and that it can still be greatly improved

Let us make this vulnerable point a little clearer by considering the conditions here in Boston I assume there are approximately 50 000 kilowatts of alternating current energy used here Nearly all of this is subject to the losses of transformers If the transformers used with this system were made more than ten years ago they probably involve a total loss due to eddy and hysteresis of about $1 000 per day at the ten-cent rate Transformers as they are made to-day by using improved iron are saving nearly half of this loss but there still remains over $500 loss per day to serve as a subject for interesting research work

It should also be noted that Boston uses only a very small fraction of the alternating current energy of this country

Consider for a moment two references to the sciences and industries in Germany and England Dr O N Witt professor in the Berlin Royal Technical High School reporting to the German government in 1903 says What appears to me to be of far greater importance to the German chemical industry than its predominant appearance at the Columbian World's Fair is the fact which finds expression in the German exhibits alone that industry and science stand on the footing of mutual deepest appreciation one ever influencing the other etc As against this Prof H F Armstrong of entirely corresponding prominence and position in England says of England Our policy is the precise reverse of that followed in Germany Our manufacturers generally do not know what the word research means They place their business under the control of practical men—who as a rule actually resent the introduction into the work of the scientifically trained assistants If the English nation is to do even its fair share of the work of the world in the future its attitude must be entirely changed It must realize that steam and electricity have brought about a complete revolution that the application of scientific principles and methods is becoming so universal elsewhere that all here who wish to succeed must adopt them

So long as motors burn out so long as subways are tied up by defective apparatus so long as electric motors can run too hot so long as street cars can catch fire from so-called explosions of the current so long as the traffic of a whole city can be stopped by a defective insulation or a ten-cent motor brush there will probably be the equivalent of research laboratories somewhere connected with the electrical industries where attempts will be continually made to improve

Electrical Effects Accompanying the Fermentative Activity of Yeast

Prof. M C Potter at the recent soirée of the Royal Society exhibited an apparatus consisting of a glass jar containing a porous cylinder and into each of these are introduced solutions of glucose of equal concentration Two platinum electrodes are placed one in the jar and one in the porous cylinder and on the introduction of yeast into one of the solutions the whole constitutes a type of galvanic cell The leads from the electrodes are connected with a condenser and the condenser is discharged through a galvanometer by means of a Morse key By this method the E M F developed through the action of the yeast may be registered and compared with that derived from a standard cell

Perpetual Stamp Pads (Deiterich's)

Thirty-five parts of Japanese gelatine Tjen Tjan are boiled until dissolved with 3 000 parts of water passed boiling hot through flannel rinsed with 600 parts of glycerine and concentrated by evaporation to 1 000 parts One hundred parts of this mixture mixed with 6 parts of methyl violet 3B or 8 parts of eosine BBN or 8 parts of phenyline blue 2F or 5 parts of anilyne green D or 10 parts of nigrosine supplies the correspondingly colored stamp pad which is poured into a shallow tin box and covered with thin muslin (mull) If the surface becomes too dry it may be moistened with water or glycerine.

Diesel Marine Engines—III*

A Resume of Recent Performances

By Herr Th Saeuberlich of Osterholz-Scharmbach

Concluded from Supplement No 1847, page 334

The introduction of the crude oil motor especially the Diesel motor may be regarded as of epoch making significance in the fishing industry In other countries notably in Holland and Denmark there are already many small vessels working with motors but Germany has only a small number to show Generally speaking the fishing trade in Germany in recent years can only be described as bad and in face of this fact the introduction of the Diesel motor to-day must appear especially full of promise for it gives a new perspective to the herring fishery and it is to be hoped will have great influence in bringing about the fulfillment of the dream that Germany's requirements in the way of herrings may be met by Germany's own fisheries At present only a fraction of her needs is covered by her own production

The motor lugger Ewersand now to be described returned at the end of October from a five weeks fishing cruise on which she had been sent for trial purposes by the Frericks Company in conjunction with the Bricker Herring Fishery and not more than three tons of crude oil was used while steam luggers on the same work used twenty tons of coal The fuel consumption of three tons of oil can be still further reduced since on this cruise especially bad weather prevailed and by carelessness of the crew a portion of the oil was lost.

It was thought advisable to provide for a small auxiliary plant exactly similar to that usually employed on sailing luggers for hauling in the nets It would have been an easy matter to haul in by the motor but it was not considered advisable at first to have the safety of the net entirely dependent on the motor The motor has proved itself reliable in the worst weather and on the last return voyage from the fishing ground ran for about seventy-five hours in a high sea without interruption

The fuel is stored in a fixed tank in the engine room and takes comparatively little room in a position forward which has not been occupied previously

A further advantage gained from the employment of crude oil is that the cleansing of the herring casks in which generally speaking a part of the coal is stored is obviated

Trials have shown that in every respect crude oil can be relied upon for work at sea and that in consequence of the small space required and the low fuel consumption there can be no doubt that it will replace steam engines for herring fishing boats

In the construction of the motor equipment of the herring lugger now to be described it has again been kept in mind that everything should be as simple as possible Above all it was of importance because in uncustomary work this constitutes the chief difficulty that in bad weather extensive overhauling and repair should be rendered wholly unnecessary

The construction of the lugger motor is for the most part the same as that of the service boat engine already described A high-speed two-cylinder motor developing 80 to 90 effective horse power with 330 revolutions is used reversing being effected by a friction coupling and gearing From the constructional point of view special attention may be directed to the pedestals and the separate cylinders—see Figs 20 to 22 The peculiarity of the construction consists in the fact that the front column can be removed without taking the engine apart and therefore it is possible if required to take out the crank shaft from the front without much trouble Having regard to the limited space in craft of this sort it becomes an absolute necessity that every part should be readily accessible

With the reversing drive—Fig 23—it is possible to carry out three different evolutions the fly-wheel revolving constantly in one direction

(1) Friction coupling and brake blocks disengaged The propeller shaft remains stationary The small pair of wheels driven by the wheel keyed to the crank shaft on the large wheel on the propeller shaft, the casing and the friction coupling revolving in the same direction as the fly wheel but at half its speed In this state the engine runs light

(2) Ahead gear friction coupling and brake engaged The fly wheel brake ring and coupling form a rigid system with the wheel casing The direction of rotation and number of revolutions of the propeller shaft are the same as that of the crank shaft

(3) Astern gear coupling thrown out of gear brake blocks thrown into gear In this case the wheel casing is held fast and with it the arm B The wheels again revolve separately and the propeller shaft now revolves in a contrary direction to the crank shaft.

Reversing gears and reversing screws make exceedingly simple engine construction possible especially the employment of a small number of cylinders, and on this account are to be specially recommended for the rough work of the fishing industry

Comparisons—It may now be not uninteresting to draw a few comparisons between motor and steam ships but it stands to reason that in so doing only the most important points can be noticed and it would not be fair to generalize from these comparisons Such comparisons are influenced to a high degree by the size and especially by the kind of vessel and the purpose for which she is employed Moreover the efficiency of the screw has to be left out of account It is therefore only possible to show in broad lines the advantages of the Diesel engine for marine propulsion

If the service boat above described had been fitted up for steam an engine of only 100 indicated horse-power could have been employed and it would have given the vessel a speed lower by about 1½ knots and a towing power of no more than 1 320 kilos. Besides only a short cabin could have been accommodated In Table II are given the relative dimensions of three vessels for comparison

I —Motor service boat

Ia —Steam service boat of same dimensions and displacement as the motor service boat

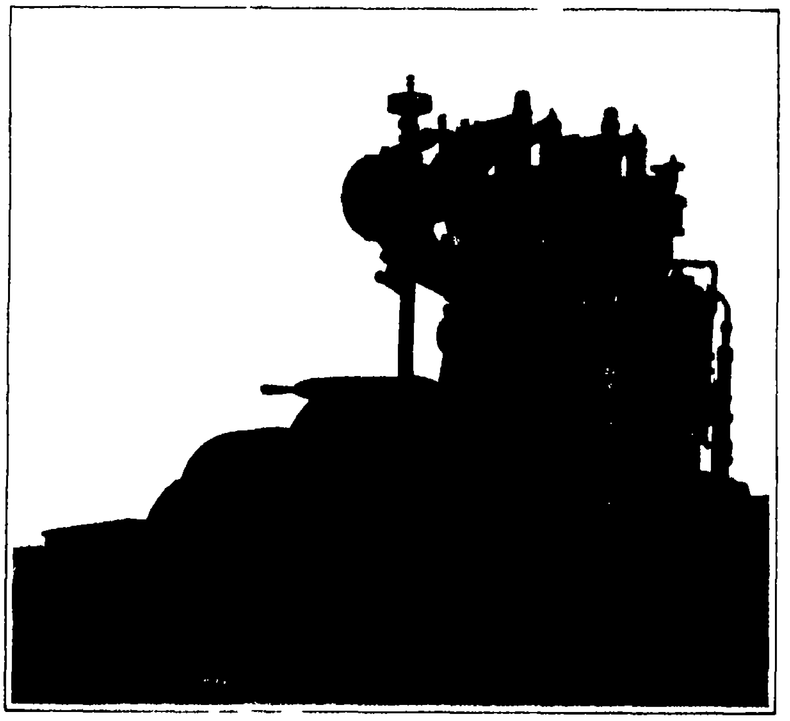


Fig 20—90 HORSE POWER TWO CYLINDER ENGINE OF THE EWERSAND—FRONT

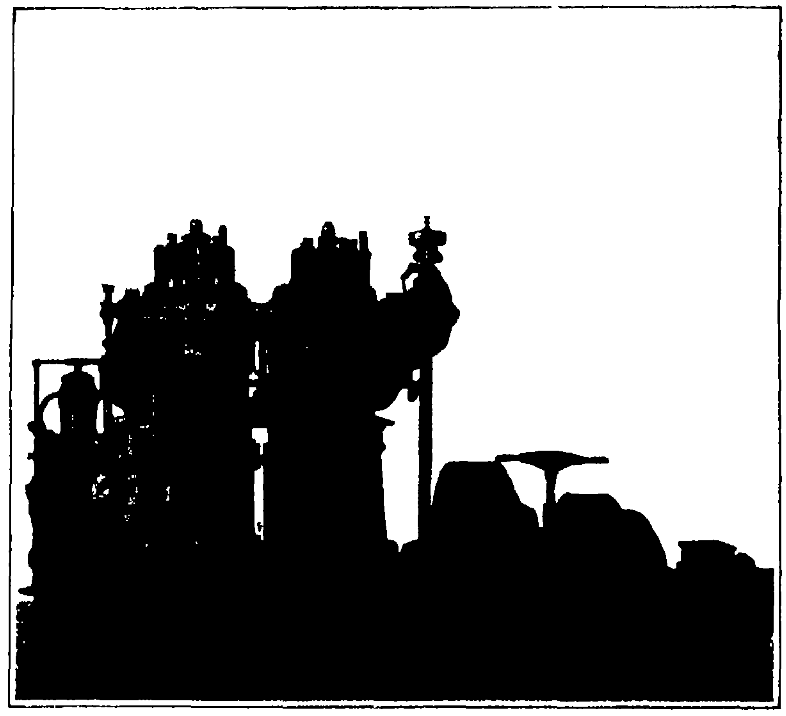


Fig 21—ENGINE OF THE EWERSAND BACK

TABLE II —Service Boat

	I	Ia.	II
Vessel s dimensions, length m	18 00	18 00	21 50
beam m	4 90	4 90	4 30
depth, m	2 50	2 60	2 60
draught, m	1 90	1 90	2 00
Weight of ship equipped fully with oil or coal to 240 sea miles radius of action tons	2 3	72 5	106
Normal power of engine or motor H P	160	80	160
Pull on the tow rope at 5 knots speed kilos	2300	880	2300
Radius of action in sea miles	240	240	240
Speed without towing about knots	6	8 0	9 5
Time for 240 sea miles at above speed without towing hours	[illegible]	30	25¼
Oil or coal consumption for 240 sea miles say	1000	3200	5100
Coal consumption for 240 sea miles say	75	58	92
Cost	£300	£2600	£3250
Steam Boat—			
Smaller towing power than motor vessel	60	—	—
Lower speed than motor vessel say	16%	—	—
Loss of time in proportion to the motor vessel	19%		
Greater cost than motor vessel	—		£250
Greater working cost per 1000 sea miles than motor vessel	—	—	£3 10s

TABLE III —Lugger

	Motor lugger	Steam lugger
Ship s dimensions length m	27 36	27 36
beam m	6 50	6 50
depth m	3 23	3 23
Speed say knots	7 5	7 5
Displacement cubic metres	254	254
Lugger on the home voyage with full equipment, but without cargo tons	140	164
Number of casks below deck	760	600
fish compartments	12	9½
Cargo weight tons	114	90
Number of nets	160	130
Average fuel consumption per voyage in kilos. say	3000	30 000
Average fuel consumption per voyage	£7 4s.	£18
Cost without fishing equipment say	£3500	£3500
Motor lugger more casks	160 = 21 %	—
nets	30 = 16 %	—
average lower working cost per voyage, say	£13	—
Crew	Same in both cases	

TABLE IV —Fishing Boats.

	Motor vessel.	Steam vessel.	Steam vessel.
Length m.	36 5	36 5	39 3
Beam m	6 7	6 7	7 0
Depth, m.	3 75	3 75	4 [illegible]
Motor or engines indicated horse power	400	300	450
Speed about, knots	11	10	11
Maximum displacement, cubic metres	400	400	[illegible]
Radius of action	the same for all 3 ships		
Fuel for one voyage about 21 days, kilos.	33,000	160,000	180,000
Fuel cost	£73 15s.	£200	£[illegible]
Fish and ice capacity cubic metres	165	115*	165*
Fish and ice tonnage	105	94	105
Crew men	12	10	14
Cost	£8000	£7000	[illegible]

*Including reserve bunker.

* Abstract translation by *The Engineer* (London) from a paper read before the Schiffbautechnischen Gesellschaft and published in the *Journal* of the Society by Julius Springer Berlin.

III Steam service boat of the same towing power as the motor service boat.

The comparison between a steam trawler and a motor propelled trawler is even more favorable to the latter

A motor lugger of exactly the same body plan and of the same dimensions as a steam lugger is in consequence of the smaller space occupied by the engine and its lighter weight, in a position to take at least 160 more casks of herrings below decks than the steam lugger and can also carry at least 80 more nets Taking the value of the herrings at 30s per ton the Diesel boat is able to earn about £1 125 more per year

To this must be added a very notable economy in fuel

For the purpose of comparison particulars of three vessels are given in Table IV The first is a motor fishing vessel of the small type the second a steam vessel of the same dimensions and the third a steam boat of larger size

In conclusion two cargo ships of about 5 400 tons burden—one driven by oil the other by steam—are taken for comparison the former being under the disadvantage that it carries its own fuel for the return voyage while the latter does not.

The concluding pages of Herr Saeuberlich s paper are occupied with a discussion of the sources of Diesel oil throughout the world its cost and the ports at which supplies are purchasable Its price free on board at Hamburg is given as between M 45 and 50

Experiments with the Blind

IT is a well known fact that blind persons can perceive obstacles near them when walking either in front of them or at the side, or when standing still they perceive the approach of objects even when these objects approach very slowly and without noise This perception remains even when the person and the object are both quite at rest. Some claim that blind persons have a sixth sense called sense of obstacles or by various other names. Many opinions have been given by scientists as to the cause of the sensation and it is claimed that it is due to air pressure heat an unknown emanation or else to hearing. M Truschel inclines to the last claim, after making experiments at the Blind Institution of Paris in the presence of Dr Marage a prominent authority and other persons First the blind man is seated and the author holds out a large sheet of carboard hung from a cane bringing it near the person very slowly some times in front and at others from the top downward or making other movements Five blind persons one of them a professor were chosen First the subject has the head bare He perceives the object well on the two sides less so in front and never behind him Second he stops the ears as well as the nose with the fingers Here he never perceives the object before it touches him Third using 1½ inch rubber tubes put in the ears the effect is much less Fourth when his head is enveloped in stiff paper the distance at which he notices the effect is lessened When a wool hood is used the effect becomes better and the same is found for cloth of different thicknesses and colors However surrounding the head by a cardboard cylinder cuts off the effect entirely as the cardboard replaces the distant object and he perceives it alone When the floor is covered by carpet or the ground snow covered there is scarcely any effect given and when there is no noise in the room the person no longer feels the approaching object. On the contrary he feels it strongly when there are vehicles or tramways passing in the neighborhood or else there is the noise of a fountain a brisk fire or the like. It thus appears that sound plays the most prominent part in this supposed sixth sense It is recognized that blind persons can sometimes make use of other sensations such as air movement heat odors etc but these are always felt as such

TABLE V —*Cargo Vessels*

Type of ship	Motor	Steam
Dimensions, length m	108	108
beam m.	14 6	14 6
depth, m.	9 6	9 6
draught m.	6 55	6 57
coefficient of displacement	0 78	0 78
Effective H P taking mechanical efficiency at 80 per cent.	1350	1500
Gross tonnage	5550	5400
Fuel (double voyage for motor ship single voyage for steam ship), tons	350	480
Carrying capacity tons	5200	4920
Advantage in favour of motor vessel	280 tons	
Speed knots	10	10
Fuel consumption (0 220 kilo/E H P 0 550 kilo/I H P) daily tons	7 13	19 8
	£ s d	£ s d
Fuel cost (£1 14s. for oil 15s. 8d for coal) daily	12 2 0	15 11 0
Advantage of the motor ship daily	3 9 0	
Crew 1 First engineer £15 per month	15 0 0	15 0 0
1 Second £9	9 0 0	9 0 0
1 Third £5	5 0 0	5 0 0
1 Eng Assist. £3	—	3 0 0
1 Fitter £5	5 0 0	—
6 Stokers and trimmers	—	22 10 0
2 Greasers at £3 15s	7 10 0	—
Keep 1s. 2½d. per man daily	10 16 0	18 0 0
Total wages and keep	52 6 0	72 10 0
Advantage of the motor vessel per month	20 4 0	

Saving yearly i.e. for four single voyages at forty steaming days—

	£ s d
(1) More earned in freight 10s. per ton for full voyage to and fro	890 0 0
(2) Fuel 160 × £3 9s	55 0 0
(3) Wages of crew 404 × 12s.	43 8 0
	1030 8 0
(4) Interest on greater cost of motor equipment	175 0 0
Yearly saving	1555 8 0

(This may perhaps be somewhat reduced in consequence of the probable increase in lubricating oil required and of the higher cost of upkeep.)

Cement for Stone Goods—Equal parts of cuttle bone and umber burned and reduced to powder are mixed with slaked lime and brick dust rubbed down with varnish and while still rubbing 0 5 part of red lead added

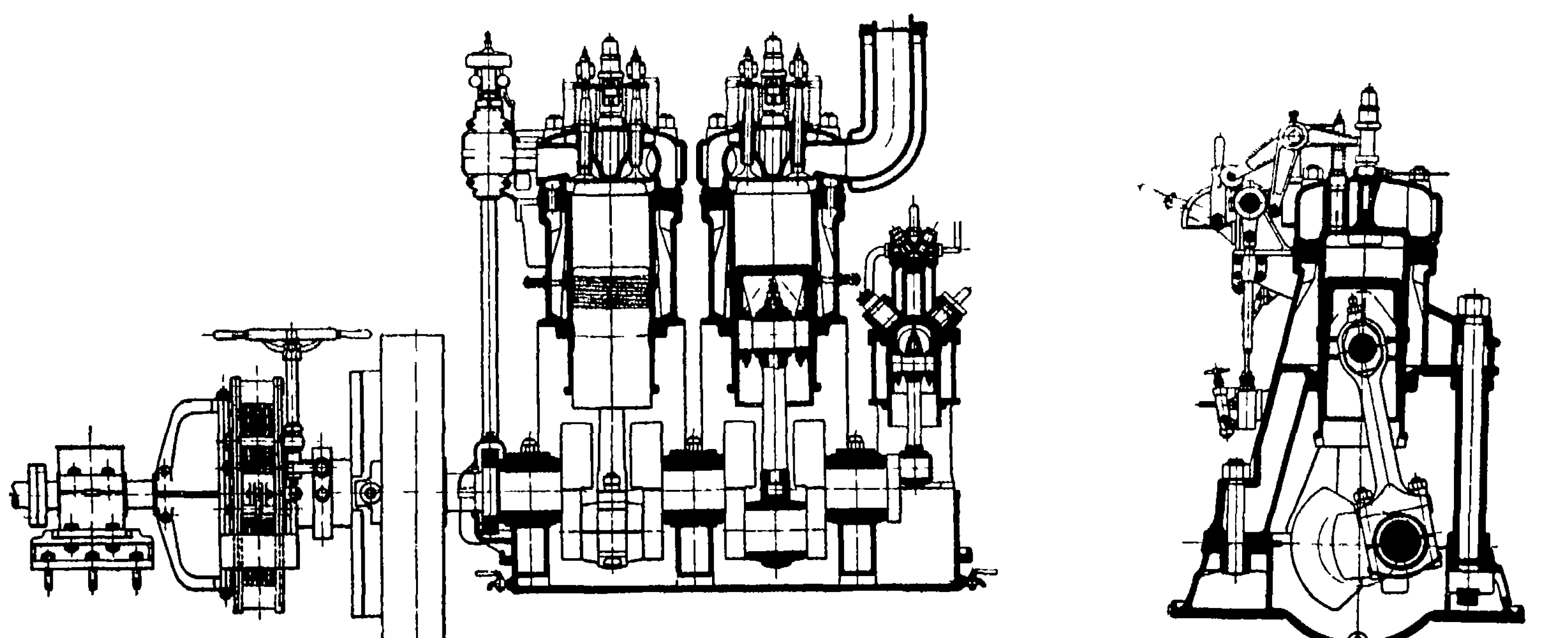


Fig 22

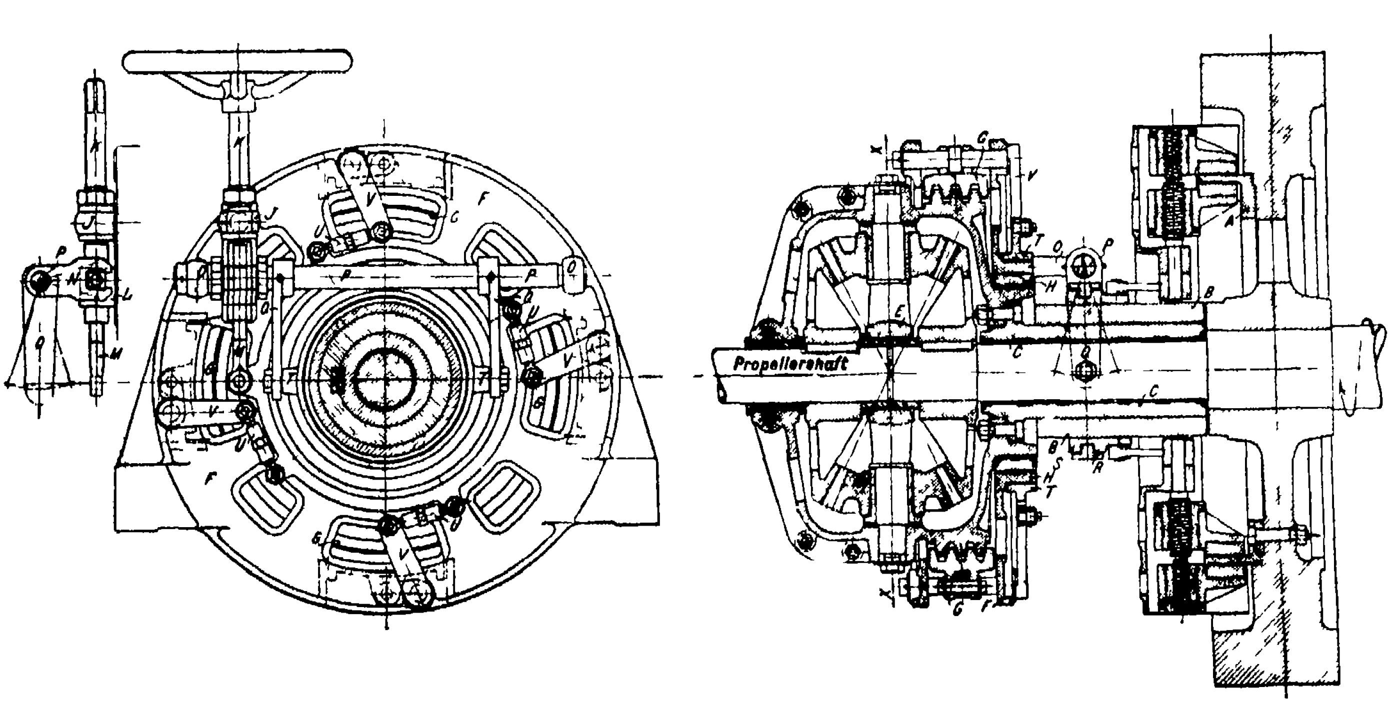


Fig 23

ENGINE AND REVERSING CLUTCH OF THE SWERSAND

Recent Advances and Problems in Chemistry

Inaugural Lecture Before the Kaiser Wilhelm Society

By Prof. Emil Fischer

This lecture was delivered by Prof Emil Fischer of the University of Berlin on the occasion of the inauguration of the Kaiser Wilhelm Society for the Advancement of Science on January 11th in the Ministry of Education at Berlin and is here reprinted from *Nature*

Prof Fischer traces the relations between science and scientific industries in Germany pointing out that by affording facilities for the prosecution of pure scientific research technical industry can only gain

At the present time more than at any other period we are inclined critically to examine the fundamental principles of all branches of knowledge and when necessary to introduce far reaching alterations in our original conclusions This state of mind applies also to the natural sciences During the last decades our actual knowledge has been extended to an extraordinary degree owing to new methods of research and in view of the more recent observations the older theories have proved in many cases to be far too narrow Even the fundamental principles of our knowledge appears to a certain extent to demand revision

Thus the progress in physical science forces us to adopt views which are incompatible with the older principles of mechanics in spite of the fact that these were regarded as unassailable by thinkers such as Hermann von Helmholtz Heinrich Hertz and Lord Kelvin

We stand in the same position with respect to the elements in chemistry Owing to the discovery of radium and similar bodies we have been forced to the conclusion that chemical elements are not unalterable and hence that their atoms are not indivisible

The same state of affairs obtains to even a greater degree in the biological sciences In comparative anatomy animal and vegetable physiology theory of evolution microbiology and almost all branches of medical science the rapid advance of experimental knowledge is accompanied by an equally rapid change in established theories Even the semi historical sciences such as geology palæontology anthropology and the venerable science of astronomy are taking active part in the general progress

Thus in these times of general scientific activity is founded the Kaiser Wilhelm Society for the Advancement of Science the primary object of which is the erection and maintenance of institutions of research

It need scarcely be said that we scientific investigators welcome this new and highly specialized creation with intense satisfaction and I regard it as a particular honor to be permitted to be the first to give expression of our profound gratitude

No one will be able to assert that experimental research in Germany has been neglected exactly the opposite conclusions must be drawn on contemplating the history of science during the nineteenth century This displays a long series of brilliant scientific discoveries made in this country The industries closely connected with science such as the chemical and electrotechnical industries fine mechanical engineering production of metals industries connected with fermentation and last but not least agriculture have also undergone in our hands a development envied on almost all sides by other nations

Should a criterion of the results of experimental research be desired this may perhaps be found in the distribution of the Nobel prizes which are awarded by absolutely independent corporations in Sweden

Only a month ago the Nobel prize for chemistry came for the sixth time to Germany this constitutes 60 per cent of all the Nobel prizes hitherto awarded for chemistry During the same period of time two and a half prizes were awarded to Germans for physics and three and a half for medicine Dr Alfred Nobel unfortunately did not provide for the remaining natural sciences

The majority of the investigations distinguished by the award of these prizes however belong to the nineteenth century Since that time matters are to some extent altered It is well known that the greater number of German scientific investigators are teachers at universities or polytechnics During the last ten years a scheme of practical education of the masses has developed which affords to all students the possibility of acquiring a thorough training in experimental science and which provides our industries with an army of scientifically educated workers. But this very education of the masses tends mentally to exhaust the teacher to a great extent certainly to a higher degree than is desirable or indeed compatible with the creative power of the investigator

There prevails in modern educational laboratories a condition of overstrained activity comparable with that existing in all but the smallest factories and commercial offices and in the harassing cares of the day the teacher loses far too readily that peace of mind and broad view of scientific matters necessary for attacking the larger problems of research This danger has been most keenly appreciated by teachers of chemistry to which body I myself belong It is therefore no mere accident that in our circles of recent years the cry for new laboratories should be at its loudest an appeal for laboratories which should permit of research in absolute tranquillity unencumbered by the duties of teaching

In place of the one State-supported chemical institute which we had planned chemists may now anticipate the immediate possession of two such institutes in which gifted men may conduct their original researches with ample means in freedom from any other duties It is anticipated that the younger generation of chemists will thereby derive special benefit By the younger generation I mean in particular those men who are at present acting as assistants or lecturers in university laboratories and who can carry on research in addition to the servile labor of teaching only by possession of an extraordinary capacity for work

That which applies to chemistry may *mutatis mutandis* be applied to the other sciences and is especially applicable to new branches of knowledge for the prosecution of which the laborious organization of educational laboratories leaves no possibility

The handicap under which we work in comparison with other nations in particular the United States of America in which similar institutes have recently been founded can thus be removed If the hopes which we all place in the new institutes are fulfilled Germany will in the future not lack recipients of Nobel prizes and we may then hope to maintain the honorable position which we hitherto have held in the domain of science

That this is however not only a matter of sentiment and honor but a palpable advantage in material respects is at once evident from the close relation between modern scientific progress and national well being I am not here to demonstrate this relation by means of statistics or political economical considerations On the contrary I would invite your attention to a cursory review of my own science I shall thus in considering the most recent achievements in this field be able to point out to you the diversity of the problems and their fertility with regard to the most varying branches of technical industry

As I have already remarked our conception of the nature of chemical elements has to some extent altered owing to the discovery of radium the first element to be discovered by a woman We are now acquainted with more than twenty four such substances—the so-called radio-active elements—and we recognize that they disintegrate spontaneously and that elementary transmutations are hence possible

Germany took at the outset only a small part in the notable researches connected with the discovery of these elements although the first stimulus leading to the discovery of radio-activity was given by the Rontgen rays The reason for this is that Germany possesses none of the raw materials necessary for the production of radium and that the majority of German investigators have not the means for the purchase of this costly element This lack of means was especially keenly felt when radium first found profitable application in the fields of medicine

We are therefore all the more delighted to record such an event as the recent discovery due to Prof Otto Hahn of the chemical laboratory of the University of Berlin[1] He has for several years been investigating the disintegration products of thorium which is employed in large quantities in the manufacture of incandescent mantles and has in the course of his work discovered several radio-active elements the most important of which he has designated mesothorium He has, moreover succeeded in devising a process for the isolation of this substance from the valueless waste products occurring in the manufacture of thorium Hahn's preparation is the bromide of mesothorium, a white salt, which evolves the same highly penetrating rays as the corresponding salt of radium For a given radio-active power this preparation costs only one-third as much as the radium salt. Nevertheless, it is not cheap, since for this small quantity of material $2,750 was paid. Thanks to an endowment from Dr von Böttinger of Elberfeld the Akademie der Wissenschaften in this city will in a few months be in possession of 250 milligrammes of this substance, and lend it out to German investigators It would be possible yearly to produce in Germany a quantity of this preparation of Dr Hahn's equivalent to more than 10 grammes of pure radium bromide from the valueless residues after the extraction of the thorium This is approximately equivalent to the world's stock of radium. By this discovery the radium famine hitherto prevalent in Germany may be said to be relieved

The field of chemical experimentation has in the last decade been widened to an extraordinary degree by the ease with which it is possible to obtain very high and very low temperatures. High temperatures can now be obtained by means of electric furnaces with which temperatures up to 3 000 degrees are easily produced Low temperatures may be obtained by means of liquid air This commodity can now be purchased in Berlin at the comparatively low price of 43 cents per liter For this we are indebted to His Majesty the Kaiser who invited Prof. von Linde, of Munich to erect here one of his large machines for the liquefaction of air[2] You will understand how indispensable this liquid has become when I tell you that in the laboratories of the University of Berlin several liters are daily consumed for scientific purposes

Far more effective is liquid hydrogen which affords a temperature lying 60 deg C below that of liquid air The boiling point is as low as —252 6 deg C only 20 4 degrees above the absolute zero ' The lecturer here explained that liquid hydrogen could not at the present time he obtained in Berlin but that he was nevertheless able to show it to his audience as he had received a shipment of the liquid prepared that morning from the University of Leipsic He went on to show how the extreme lowness of the temperature of the liquid can be demonstrated by transferring a small quantity from its container into a transparent glass vessel and immersing in it a glass tube sealed at the bottom On removing the tube it is seen to be filled with a white solid resembling snow this is solid air when once removed from the cooling liquid the solid melts after a few moments

Referring to the main stock of the liquid from which he had drawn his sample for the experiment Prof Fischer went on

'The remainder of the liquid hydrogen in the containing vessel is to serve to-day for scientific purposes At the end of my lecture it will find its way to the physico-chemical laboratory of the university there to be employed this evening and during the night by Prof Nernst for his important researches on the specific heat of the elements at temperatures in the vicinity of the absolute zero

When the Kaiser Wilhelm Institutes for Chemistry are once in full swing we shall I hope no longer be obliged to travel to Leipzig every time we want some liquid hydrogen.

Liquid hydrogen was prepared for the first time about twelve years ago by Prof Dewar in the famous laboratory at the Royal Institution in London But the costly experiments necessary for its production were rendered possible only by the liberal means which Dr Ludwig Mond the great benefactor of chemistry, placed at his disposal Dr Mond, moreover has not forgotten his German Fatherland and German science He bequeathed to the University of Heidelberg, where he had studied the sum of $250 000 for chemical and physical research and several years ago he endowed the State-supported chemical institute which he had planned, with the sum of $50 000.

Inorganic chemistry, in which, thirty years ago advance was scarcely considered possible, has, owing to the new aids to research—as for example, high temperatures and powerful electric currents, etc.—undergone absolutely unexpected developments. I will merely give you some idea of this development by indicating a few processes of technical importance, beginning with the attempts to prepare valuable nitrogenous compounds from the nitrogen of the atmosphere.

"The direct production of nitric acid from air[3] by means of a powerful electric discharge has reached

[1] Dr Hahn made the discovery of the mesothorium in the laboratory of University College, London, while investigating some thorianite residues given to him by Sir William Ramsay.

[2] A similar apparatus was independently devised and simultaneously patented by Dr. William Hampson in London.

[3] First carried out on a [illegible]

the [illegible] of large-scale manufacture In Norway at the present moment a gigantic works, by the side of a mighty water-fall, is in course of erection by German factories in conjunction with Norwegian engineers, and supported by German and French capital.

Synthetical saltpeter is already on the market, since German dye factories derive a considerable portion of the nitrites necessary for their work from the same source.

The strikingly original process devised by Prof A. Frank and Dr N Caro in Charlottenburg for the preparation of calcium cyanamide from calcium carbide and atmospheric nitrogen came somewhat earlier into practice

And now a third process, based upon the direct combination of atmospheric nitrogen with hydrogen to form ammonia, has been announced Prof Haber of Karlsruhe by means of an ingenious application of the laws of physical chemistry has succeeded in obviating the difficulties which hitherto have rendered this synthesis impracticable The well known Badische Anilin und Sodafabrik at Ludwigshafen am Rhein has taken over his patents and technically perfected the process to such a degree that synthetical ammonia will in all probability shortly be placed on the market

"The greater the number of such processes and the keener the competition which they excite the greater is the benefit to the consumer In the case I have just mentioned this has an especial significance as the bulk of technical nitrogenous substances are employed in agriculture for artificial manures

In the opinion of high authorities German agriculture could easily consume twice nay thrice the amount of nitrogenous material at present employed for this purpose were only the price to fall to a corresponding degree In such a case it is possible that the crops would increase to such an extent that Germany could be independent of foreign countries with respect to agricultural produce A task of great national importance has thus been set to chemical industry

This last process the synthesis of ammonia possesses the advantage that no electricity merely heat is involved In other words all that is necessary is fuel a commodity of which Germany has ample store Furthermore it is to be noted that the cost of production depends only on the price of hydrogen which together with the inexpensive atmospheric nitrogen serves as raw material The problem of producing hydrogen at a moderate cost has already been solved by chemical industry owing to the great interest recently taken in airships In this way the truth of the old saying is established that all industries affect one another and that improvements in one field may occasion fertile results in totally remote spheres of activity

Such a relation of mutual stimulus obtains also between theoretical chemistry and the production of metals The production of gold silver and copper has gained in simplicity to an extraordinary degree by the introduction of electrochemical methods The study moreover of alloys and the perfecting of inexpensive methods of preparing metals hitherto obtainable only with difficulty such as chromium tungsten manganese vanadium and tantalum has been of immense benefit to the steel and electrotechnical industries"

As an example of the latest production of these industries, the lecturer at this point exhibited to his audience some samples of a new modification of iron so-called electrolytic iron This material is prepared at the Langbein Pfannhauser factory in Leipsic by a process devised by Prof Franz Fischer in the laboratories of the University of Berlin the iron being deposited from a solution of an iron salt by an electric current The material can be readily rolled or drawn into wire The samples had the form of extremely tough plates reaching a thickness of five millimeters and showed a bright surface which is not due to any polishing the metal being detached in that state from the electrode. Among the samples exhibited was a seamless iron tube coiled in serpentine fashion which had been deposited upon a leaden core

This electrolytic iron is distinguished from all other commercial varieties by its extraordinary purity, in consequence of which it possesses distinctive physical properties. In particular it is much more readily magnetized and loses its magnetism far more rapidly than other kinds of iron this property rendering it especially suitable for electromagnets. To illustrate this point, the lecturer here exhibited an electromotor of ordinary design which had originally developed one-half horse-power but which, on replacing the original electromagnets by others constructed of electrolytic iron, had its performance raised to 1¼ horse-power This iron should prove of the greatest importance in the construction of electromotors.

Referring to the much discussed question of the husbanding of our natural resources, Prof Fischer went on

Our present-day material civilization is to a great extent founded on the rapid utilization of the fossilized combustibles anthracite and brown coal But posterity will not fail to reproach us with having grievously squandered this valuable material for in the conversion of the heat of combustion of coal into energy in the ordinary way by means of steam engines more than 85 per cent of the work potentially contained in the coal is lost This loss however may be appreciably lessened by suitable chemical treatment of the coal If the coal be first converted into combustible gas—so-called power gas—and this then consumed in a gas engine the output of useful power is treble that developed in a steam engine Valuable by products—ammonia and tar—can moreover be recovered and indeed the methods hitherto employed for the production of power gas are in many respects capable of improvement I therefore deem it possible that at some time special institutes will be founded in the centers of the coal districts—perhaps under the auspices of the Kaiser Wilhelm Society—where these important problems can be investigated with the aid of all the methods known to science

Fossilized combustibles which owe their origin to the vegetable kingdom form a connecting link between mineral and organic substances Organic chemistry surpasses inorganic chemistry in variety of methods and products to the highest degree Small wonder for it embraces all those complicated chemical bodies which occur in animal and vegetable life The number of organic substances accurately investigated may to-day be estimated at the high figure of 150 000 and every year eight or nine thousand more are added to the list We may therefore reckon that at the close of this century organic chemistry will comprise the entire gamut of substances found in the animal and vegetable kingdoms

This rapid increase is wholly due to organic synthesis From the few elements occurring in organic chemistry of which carbon predominates all these compounds are built up much as an architect produces the most diverse edifices from the same form of brick

Synthesis in organic chemistry is an offspring of Berlin It was born eighty two years ago in the Niederwallstrasse by the synthetical production of urea by Friedrich Wohler It has moreover found its greatest field of activity in Germany It stands no longer in fear and trembling of the complicated constituents of the living organism I shall demonstrate this fact by discussing the three classes of substance predominating in organic life the fats the carbohydrates and the proteins The synthesis of fats was effected so far back as two generations ago by Mr Berthelot in Paris The first synthetical carbohydrates—grape sugar fruit sugar etc—saw the light twenty years ago in Würzburg and the methods for the synthetical building up of albuminous substances have been worked out during the last ten years in the laboratory of the university of this city

Through such things as these proteins carbohydrates, and fats organic chemistry is brought into close touch with the biological sciences for the entire metabolism in the living organism is merely a sequence of chemical transformations which these substances undergo Chemistry is thus called upon to partake in the solution of the great riddles of life Nourishment growth reproduction heredity age and the manifold pathological disturbances of the normal state It is not surprising that the keenest activity exists in these interesting fields of work and we may safely hope that provision will be made for biological research in the new Kaiser Wilhelm Institutes

The example given by the magnificent institute here in Berlin for the study of the problems of the industries connected with fermentation in which the results of scientific research meet the practical requirements of brewers and distillers serves to show how fruitful can be the collaboration of biologists and chemists

Moreover chemical and many other industries have derived great benefit from organic chemistry A few examples from recent times will illustrate this fact.

The most widely distributed of all the carbohydrates is cellulose of which cotton and linen are entirely composed and which is the chief constituent of wood and plant fibers And what a variety of articles is nowadays manufactured from cellulose! Paper collodion, celluloid photographic films smokeless powder artificial silk artificial hair artificial leather"

In illustration of the cellulose industries the lecturer displayed before the audience samples of artificial silk and horse hair and films in great variety All these products, he said had been prepared by ingenious combinations of chemical and mechanical processes. Artificial silk and hair in spite of their striking similarity to the natural products, Prof Fischer explained, were of totally different composition from these, which are not derived from cellulose but belong to the class of proteins The lecturer further pointed out that the magnificent colors with which the artificial textures were dyed were the work of organic chemistry They belong he said to the family of synthetic coal tar dyes This subject is to day so large that complete half yearly courses of lectures are delivered upon it at the universities. Hundreds of such dyes are on the market and the value of the dye stuffs produced in Germany the majority of which are exported approximates to fifteen millions of pounds sterling

Of all these dyes I shall only mention synthetical indigo because this substance was the most difficult of all to synthesize and on the other hand was a great commercial success

This synthetical product is not only much purer in composition and color than the natural dye stuff but also considerably less expensive On this account the cultivation of the indigo plant in India has diminished to one sixth of the original extent and will to all appearances soon disappear altogether[1] Woolen and cotton goods are now dyed with German indigo even in Asia to which continent a quantity of indigo worth no less than $9 500 000 was exported in the year 1909

While on this subject I may refer to the two most important coloring matters of animal and vegetable life chlorophyll and hæmoglobin The former plays an important part in the chemical process upon which all life depends—I refer to the conversion of the atmospheric carbon dioxide into sugar which takes place in green leaves under the influence of sunlight The red pigment in the blood fulfills in our own bodies the important function of transporting the oxygen from our lungs to the tissues thus rendering possible that process of combustion which forms the basis of our bodily and mental strength

The lecturer here showed two specimens of pure chlorophyll of which one was crystalline He remarked I owe these rare preparations to Prof R Willstätter of Zurich who of recent years has been studying this coloring matter with remarkably successful results Hæmoglobin has also lately been thoroughly investigated in Stuttgart and in Munich and the remarkable conclusion has been drawn from these investigations that chlorophyll and hæmoglobin are closely related This fact thus denotes a species of consanguinity between the animal and vegetable kingdoms This must however be of great antiquity—that is to say to date from remote times when the animal and vegetable kingdoms were as yet not distinct

Of greater commercial importance than the coal tar dyes is India rubber Its consumption is continually increasing, and is estimated at some 70 000 tons yearly an amount corresponding in price to about one hundred and seventy five millions of dollars You can therefore readily understand that this subject has attracted the attention of synthetic chemists and for the last nine months one has heard even in public of attempts to prepare synthetical India rubber In fact in August 1909 Dr F Hofmann and Dr C Coutelle chemists to the Elberfelder Farbenfabrik succeeded in devising a practical process for its synthesis The starting material is a volatile mobile and colorless liquid termed isoprene[2] which in turn can be readily synthesized from even simpler substances

This liquid is converted into India rubber merely on heating in closed vessels The lecturer here exhibited a sealed glass tube which had been originally filled with a mobile liquid isoprene but which after heating contained a jelly like mass of synthetical India rubber Pointing to this he said When thus prepared on a large scale the substance is somewhat denser and of a light yellow color That this product is really India rubber has been definitely established by the scientific investigations of Prof Harries in Kiel a high authority on this subject who has since independently devised another process for the same purpose

When synthetic chemistry has once taken possession of such a field it is not confined to the particular product occurring in nature but can bring forth a whole series of similar substances Other rubber like substances have been prepared not from isoprene but from similar liquids such as dimethylbutadiene Such products are termed homologues They possess properties closely resembling those of India rubber but differ slightly in chemical constitution It is as yet not decided which of these synthetical substances forms the most suitable substitute for India rubber The same applies to the far more important question of cost of production But when one considers the fate of natural indigo of madder and of other natural products one may hope to see synthetical India

[1] The recent work of Bloxam and his collaborators has demonstrated the possibility of recovering from the leaf a yield of indigo increased to such a degree that the cost of production is certainly no more than that of the synthetical product Furthermore the natural indigo is stated by some authorities to possess certain benign impurities which render it more suitable for dying purposes.

[2] First shown to yield India rubber in 1892 by Sir William Tilden (*Chem. News*, lxv., 265)

rubber gradually enter into successful competition with the naturally occurring commodity

Camphor which may be placed in the same chemical category as India rubber is also prepared artificially on a large scale The first firm to manufacture synthetical camphor was the Chemische Fabrik auf Aktien (formerly Schering) of Berlin but other firms are now following suit By this the camphor monopoly which the Japanese government was able to establish after the annexation of Formosa was broken down

Passing on to a somewhat different field the lecturer now showed to his audience samples of an artificial resin closely resembling amber in its external characteristics and capable of serving as a substitute for that substance in the production of such articles as necklaces combs cigar holders etc Samples of such articles were submitted which had been placed at the disposal of Prof Fischer by the Bakelite Company Bakelite being the trade name of the material which is prepared by a process recently worked out on a technical basis by the American chemist Baekeland

Referring next to the association of synthetic chemistry with medicine the lecturer remarked that workers in this field were actively engaged in the pursuit of the discovery of new medicaments and that the great amplitude of this subject compelled him to mention only a few instances. Thus he showed to the audience a bottle containing a white powder—veronal—which is a hypnotic largely employed at the present day It is in no way connected with the older vegetable narcotics such as opium etc. but is entirely a synthetical product. He then pursued his subject.

Organic synthesis is not limited to vegetable products only but embraces equally fearlessly substances of animal origin An instructive example of this may be found in a remarkable compound (adrenalin) which is formed in our own bodies in the suprarenal glands and which plays an important part in the regulation of the blood pressure Shortly after its isolation in a pure condition from these glands Dr F Stolz chemist to the dye factory at Höchst was able to synthesize it from constituents of coal tar This synthetical product has now been placed on the market by the Höchst firm under the name of Suprarenin A very dilute solution of this substance causes a powerful contraction of the blood vessels and consequent dispersal of blood from the tissues A skin surface well charged with blood—as for instance a red nose—is instantly rendered quite pale on painting it with such a solution Unfortunately, the color is not evenly discharged owing to the varying permeability of the epidermis and as the action of the drug soon ceases with return of the original redness adrenalin is not suitable as a cosmetic On the other hand it finds most useful application in surgery as by its means certain incisions can be made without loss of blood this is found particularly convenient for operations on the eye mouth and nose

Flora's fairest children the sweet-scented flowers must also submit to competition with synthetic chemistry The scent industry has received a powerful impetus from synthesis and yearly turns out in Germany alone goods of the value of more than ten million dollars Among the products of this industry may be mentioned ionone an artificial violet scent discovered in the laboratory of this university by the late Prof F Tiemann and manufactured by Messrs Haarmann and Reimer in Holzminden The contents of this bottle would be sufficient to envelop not only the Ministry of Education but the entire avenue Unter den Linden in an atmosphere of violet perfume for the osmophoric value of these substances is extraordinarily high

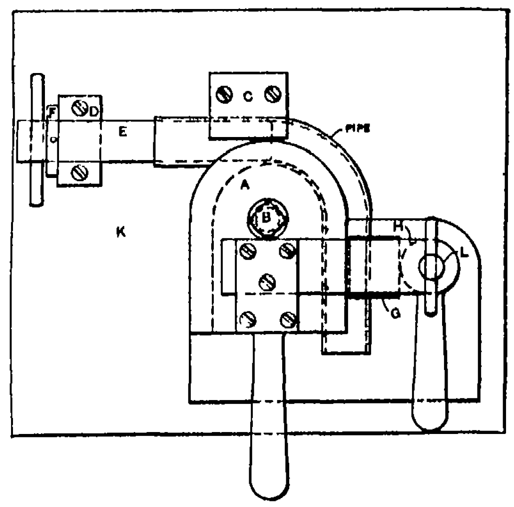
In contradistinction to the simple ionone the majority of the natural odors of flowers are due to complex mixtures of different scents These nevertheless have been successfully reproduced Among scents so prepared are lily of the valley mock orange lilac tuberose and finally the greatest achievement synthetical attar of roses Although the natural oil from roses contains about twenty different odorous substances the chemists of the scent factories at Leipzig (Heine & Co Schimmel & Co) have succeeded after laborious research in isolating all the components synthesizing those or preparing them from less costly oils and then reuniting them in the proper proportions It now requires a most sensitive nose indeed to distinguish the synthetical attar of roses from the natural product

These examples show the success which has followed the encroachment of synthetic organic chemistry in nature's domain What I have already said is sufficient to prove that chemistry as well as all natural sciences is the true field of unlimited possibility The Kaiser Wilhelm Institutes are henceforth to take part in the expansion of this field and the appropriation of the treasures hidden therein

"It is, of course not to be expected that they will entirely supplant all the older scientific institutions. We of the older institutions do not feel by any means so weak as willingly to allow such an event to occur On the contrary we shall exert our best energies to maintain a keen competition with the younger institutes. This will serve to keep both sides fresh and active

Pipe-Bending Device

The illustration shows a pipe-bending device which will be of value to anyone wishing to bend pipe with out the trouble of filling it with sand or other materials The mandrel E is held on base K by the steel block D Stop collar F is set and pinned on the mandrel in such a position as to allow the end of



PIPE-BENDING DEVICE

the mandrel to project slightly past the center line of swivel block A which is pivoted at B and rounded out for the pipe The backing block C which also fits the pipe is set so as to allow the pipe to slide over the mandrel E and keeps it from buckling while it is being drawn off the mandrel

The pipe is shown in the illustration after having been bent at right angles Before making the bend the swivel block A is set in a position parallel with the mandrel E and the end of the pipe is then placed on the mandrel It is held to the swivel block by means of a sliding block G which is locked by the eccentric lock lever H After making the bend the lock pin L is pulled out, after which the block G and the eccentric lever H can be removed the pipe may then be pulled off the end of the mandrel —*Machinery*

The Ferry Total Reflectometer

The name total reflectometer' is given to an instrument designed for the measurement of the optical refractive index of a liquid by means of the phenomenon of total reflection A recent issue of *Prometheus* describes a new form of the instrument invented by the French physicist Ferry

If AB (Fig 1) represents the surface of separation

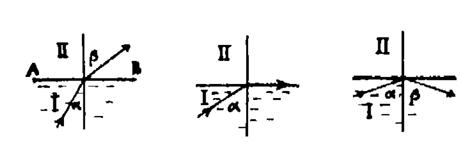


Fig 1 Fig 2 Fig 3

between water I and air II a ray of light directed upward through the water at a small angle of incidence α is reflected at the surface and emerges at a larger angle β such that the ratio $\frac{\sin \beta}{\sin \alpha}$ is equal to the ratio of the velocities of the ray in air and in water and is therefore constant for all angles of incidence (so long as any refraction occurs) This ratio is called the refractive index from water to air,

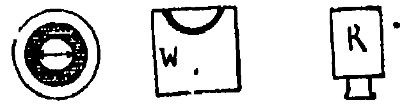


Fig 4

for light of the particular wave length employed If the angle of incidence α is gradually increased the angle of refraction β increases correspondingly until it becomes a right angle and the refracted ray coincides with the surface (Fig 2) In this case $\sin \beta = 1$, so that the refractive index is equal to $\frac{1}{\sin \alpha}$ This value of the angle of incidence is called the critical angle, for if the ray, in the water, makes a still larger angle with the normal to the [illegible] it cannot emerge, but is totally reflected at an [illegible] equal to its angle of incidence α (Fig 3)

Kohlrausch's total reflectometer the inst[illegible] most commonly used for measuring the ref[illegible] index of a liquid by means of total reflection, r[illegible] two settings and two readings for each measur[illegible], but Ferry's apparatus requires only one readi[illegible] no accurate adjustment.

A hemispherical cavity in a cubical block o[illegible] (W Fig. 4) contains a concentric glass hemisph[illegible] slightly shorter radius and the space betwe[illegible] the hemisphere and the wall of the cavity is fille[illegible] the liquid When the cube of glass is viewed [illegible] a telescope R, a dark ring, caused by the to[illegible] reflection of some of the incident rays, is seen. [illegible] internal diameter of the dark ring varies acco[illegible] to the refractive index of the liquid. This dia[illegible] is measured with a micrometer eyepiece. From [illegible] result of the measurement it is possible to calc[illegible] the index of refraction from the liquid to the [illegible], and hence, the index of refraction from the liqu[illegible] to air or vacuum, when the index of the glass is kn[illegible] The use of the instrument, however, is simplifie[illegible] graduating the head of the micrometer screw in u[illegible] of refractive index, so that the refractive index [illegible] the liquid is obtained by direct reading, without [illegible]culation.

Short Cuts in Multiplication

It is ridiculous how much unnecessary trouble s[illegible] people—let me say most people—take when they h[illegible] a bit of multiplication to do Take the three exam[illegible] here given. In the first, by the long way, there [illegible] sixteen figures and four operations but by sim[illegible] multiplying by the factors 4 8 and 4 the product [illegible] there without any addition

In the second example, which is done in two lo[illegible] and hence wrong ways of which the second is th[illegible] quicker there are still by either of these ways twelv[illegible] intermediate figures and four operations, wherea[illegible], if one would only add three ciphers and then subtra[illegible] the multiplicand the answer would be there with only six figures and two operations.

In the third example, by setting three ciphers a[illegible] before to the multiplicand and subtracting twelv[illegible] times itself the answer is obtained by writing only ten intermediate figures and performing two operations In the last two examples writing the ciphers is really not necessary Why take so much trouble? One can just imagine them there

Wrong Way	Right Way
1729	1729
128	6916
	55328
13832	221312
3458	
1729	
221312	

Wrong Ways		Right Way
	Better	
999	735	735000
735	999	735
4995	6615	734265
2997	6615	
6993	6615	
734265	734265	

Wrong Way	Right Way
345678	345678000
988	4148136
2765424	341529864
2765424	
3111102	
341529864	

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An Improved Electric Steel Furnace

By Dr Alfred Gradenwitz.

In designing the electrical steel furnace described below Dr H Nathusius has endeavored to combine the individual advantages of the Héroult and Girod furnaces while avoiding the drawbacks of either

In this furnace which is of the combined arc and resistance type there are three surface carbon electrodes penetrating vertically into the hearth compartment at the angles of an equilateral triangle These electrodes are connected up to the outside terminals of a three-phase current generator or transformer whereas three steel electrodes enchased in the bottom (which are likewise arranged at the angles of an equilateral triangle) are joined to the inside terminals of the same three-phase current generator or transformer These inside terminals are obtained by dissolving the neutral point of the machine and transferring it into the charge As accordingly the surface electrodes as well as the bottom electrodes are of mutually alternating polarities the current passes from one surface electrode to another from one bottom electrode to another and from each surface electrode to one of the bottom electrodes In fact there is inside of the charge a perfect compensation of currents, in opposition to the surface currents of the Héroult and the cross currents of the Girod furnace. This heating process, according to which the whole of the charge is traversed and encircled by heating currents obviously is as economical as can be desired

Again the fact that the current is distributed to the whole cross section of the bath that is both to its surface and bottom is bound to result in another beneficial effect by forming rotary fields which similarly as in the case of a three-phase current motor will set the surrounding iron parts rotating

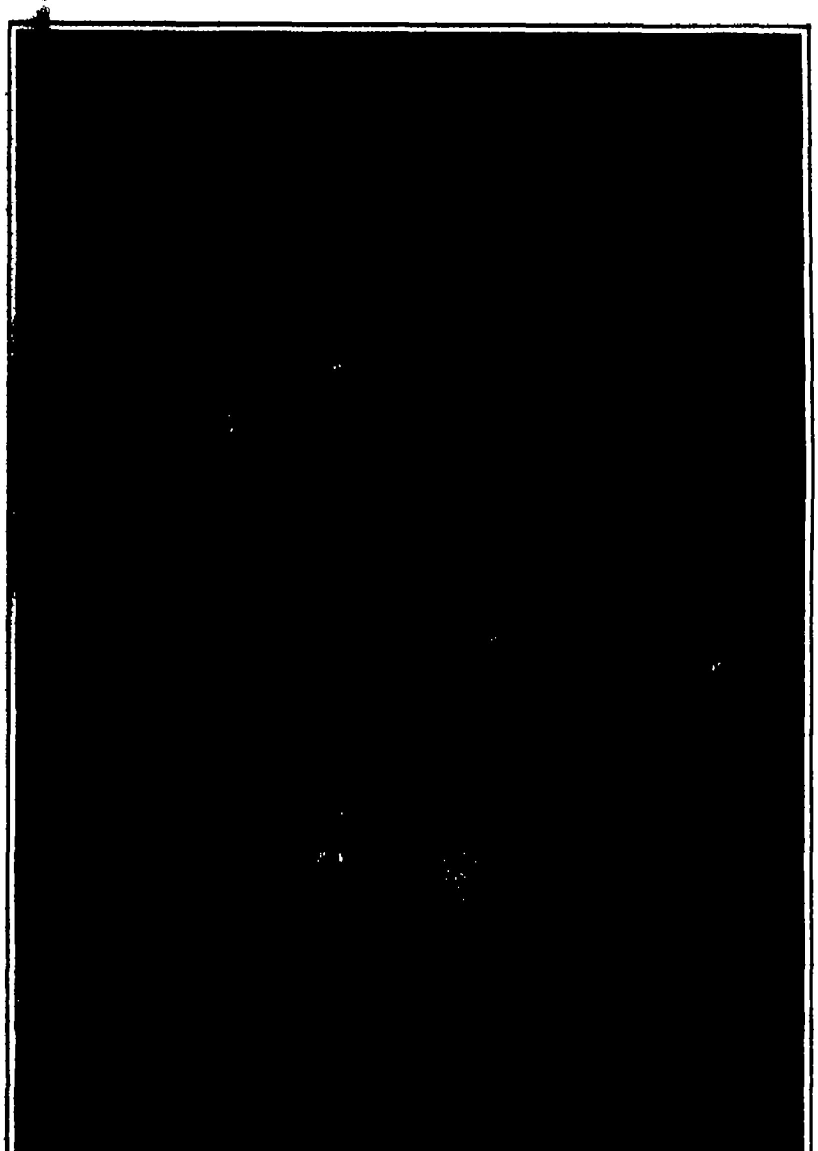
It further will be readily understood that in the Nathusius furnace with its six heating focuses located at the issue of the current from the various electrodes the bath can be heated and throughout its mass much more rapidly than in furnaces only comprising two heating centers As furthermore the surface electrodes are placed as close to one another as feasible the electric arcs will repel each other by virtue of the electro-dynamic forces exerted on one another by currents of equal direction

Apart from this advantageous heating effect, the *electrical arrangement of the Nathusius furnace* is exceedingly favorable As three phase currents are used in practically all large metallurgical works the use of this type of current is doubtless advantageous while the problem of including the charge in the circuit is solved most ingeniously by locating the neutral point in the bath itself, thus accurately prescribing the path of the current independently of any resistances As the circuit comprises not only the electric arc which is bound to vary continually but the slag layer, the steel bath and the mass rammed upon the bottom electrode any shocks produced by short-circuits in the electric arc are compensated as it were by an electric buffer thus dispensing with any furnace regulation in the case of normal operation

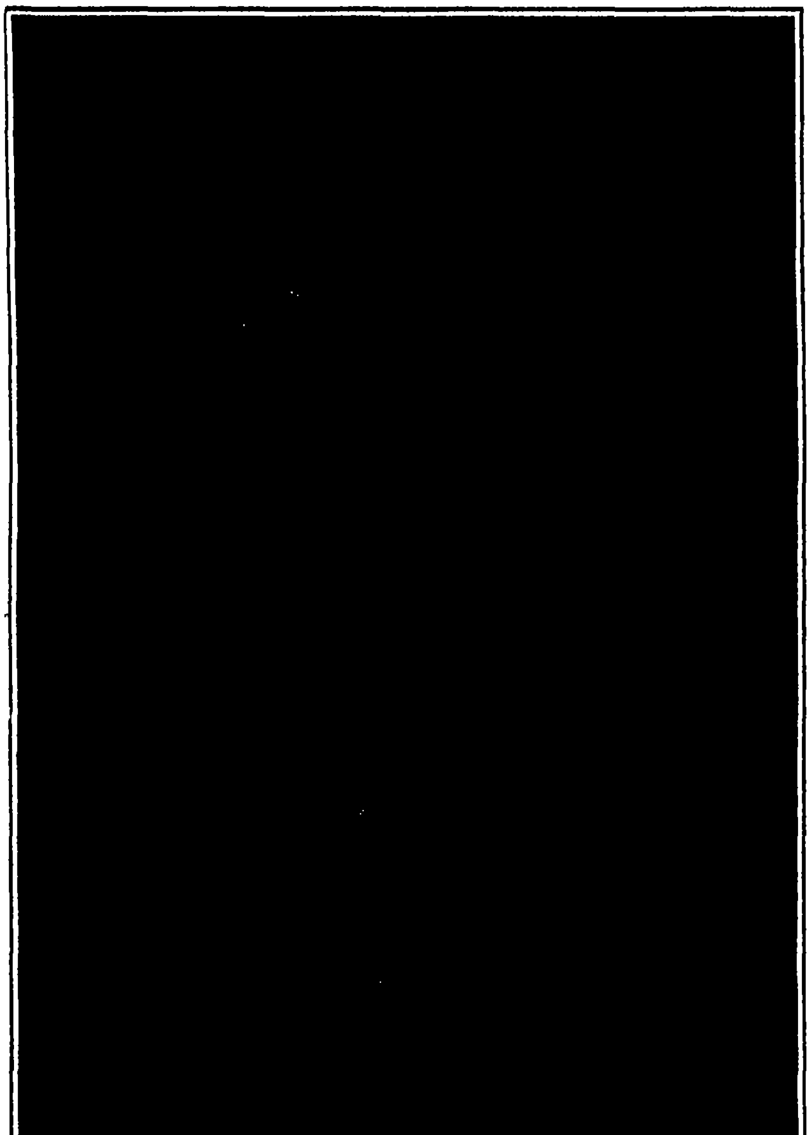
A further advantage *from the electrical point of view* is that the current flowing from one bottom electrode to the other is readily transformed to any intensity by the aid of a special generator with adjustable neutral conductor or else by means of a booster transformer As this current only flows between the bottom electrodes viz through relatively small resistances its intensity can be increased without any necessity of using machinery of excessive dimensions which obviously renders it possible to obtain very strong effects

While during the first stage of operation (the refining stage) an effective heating of the slag (the only refining agent) by intense arcs is of much importance it should not be overlooked that during the ensuing deoxidizing stage the slag acts only as a protective cover and accordingly requires no strong heating During this second stage the whole of the bath should therefore be heated as effectually as possible which in the Nathusius furnace is done by using a booster transformer and thus deriving from the electric arc a considerable amount of energy concentrated in the bath or the bottom

After once preparing the charge it is often desirable to allow the bath to rest for some time, during which stage the amount of heat to be added only



POURING OUT THE CHARGE



THE OPERATION OF TAPPING

AN IMPROVED ELECTRIC STEEL FURNACE

corresponds to the heat lost by radiation and conduction This in the Nathusius furnace is effected most advantageously by cutting out entirely the surface electrodes allowing current only to flow between the bottom electrodes and thus doing away with arc heating

Being of a round shape the furnace is pivoted in the same way as a converter upon two uprights the tilting device being operated electrically or hydraulically The bottom electrodes which are made of cast steel are fitted into the bottom from underneath they do not penetrate into the steel bath and are covered by a layer consisting of the same material as the furnace bottom The whole of the furnace except the lid consists of a rammed dolomite mass and is very durable as is also the lid which is made of argillaceous materials quartz slate and the like

A furnace constructed on the above lines by the Bergmann Elektrizitäts-Werke Ltd of Berlin which has been in operation for more than a year at the Friedenshütte Steel Works was recently tested by Dr B Neumann of Darmstadt This furnace derives its electrical energy from a three phase current transformer the high tension end of which wound for 6 000 volts is connected up to the circuit of the power house supplying the steel works The low tension winding is so designed that both ends of each of the three coils issue out of the transformer each of the three windings being connected at one end with a surface electrode and at the other with a corresponding bottom electrode The rails which are made of flat copper are designed for a permanent current intensity of 2 500 amperes The transformer is able permanently to yield 550 kilowatts and at the low tension end gives an interlinked tension of 110 volts The phase tension thus is 63 volts which disregarding tension losses in the conductors is the tension between the surface and bottom electrodes Into the conductors leading to the surface electrodes is inserted a switch which short circuits these three conductors and thus allows the bottom electrodes to be used alone for current supply

The furnace transformer is fed from the three phase current system of the local power house no unfavorable influence having ever been noticed Into the high tension circuit of the transformer are inserted a voltmeter and an ammeter and each of the three conductors leading to the surface electrodes comprises an ammeter A (Fig 1) Between the three surface electrodes are inserted three voltmeters V and three other voltmeters V indicate the voltage between each of the surface electrodes and the corresponding bottom electrode Finally the tension between the bottom electrodes can be checked by three voltmeters V Each phase of the low tension circuit comprises a wattmeter

The booster transformer having an output of 150 kilowatts is in its primary circuit likewise connected up to the 6,000 volts three phase current system of the power house As the current intensity at the low tension end depends on the variable resistance of the bottom (floor) material and the temperature of the bath the booster transformer is designed for two

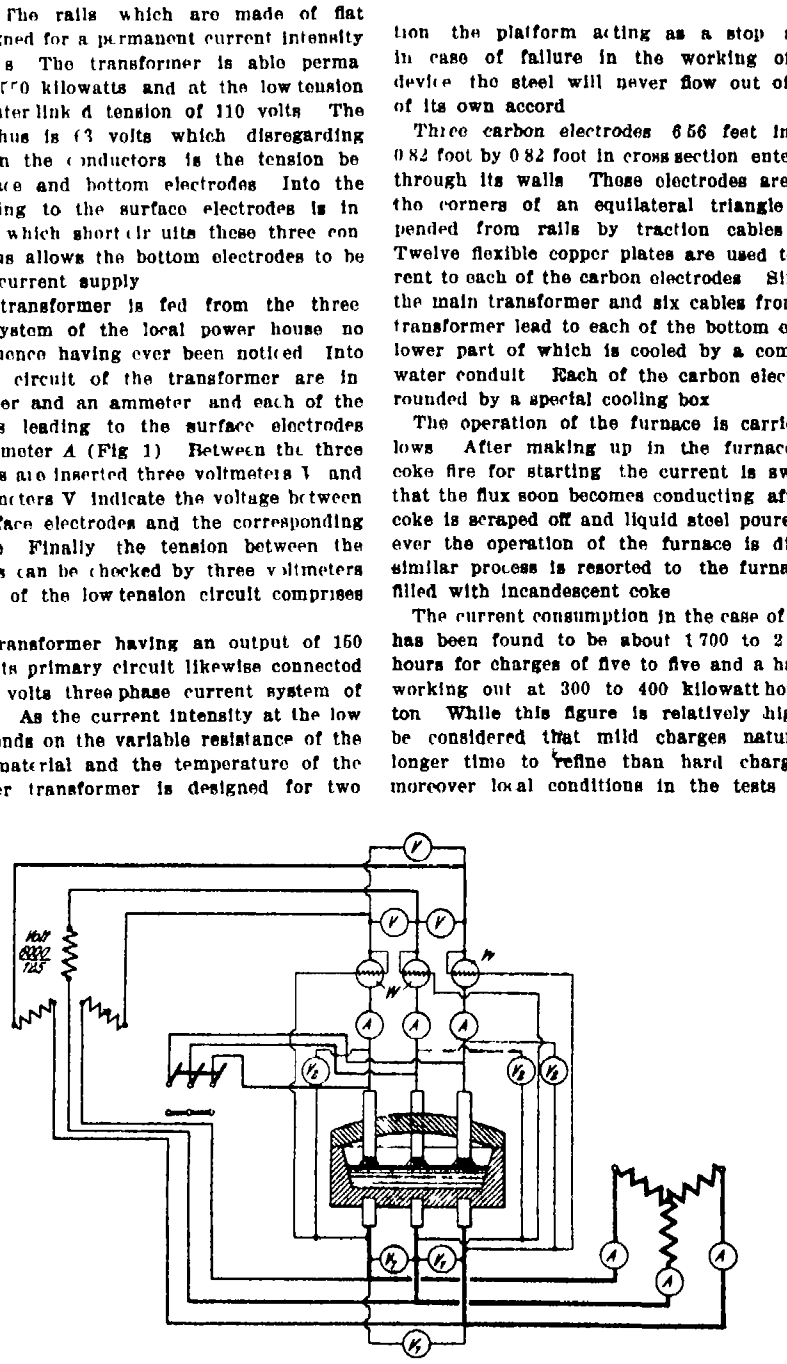


FIG 1 DIAGRAM OF CONNECTIONS

tappings for each low tension phase and is adapted to be connected up in triangle or star arrangement for each of these tappings thus allowing 16 2 19 22 28 33 or 38 volts secondary tension to be derived with a primary tension of 6 000 volts An ammeter is fitted into each conductor leading from the booster transformer to a bottom electrode

As regards next the furnace itself this is designed for a capacity of five to five and a half tons of liquid steel It is extremely simple in construction, and is tilted by hydraulic means The furnace proper consists of two parts, the hearth and a removable lid, both of which are surrounded by a sheet metal sleeve The outside diameter is 8 96 feet, and the height 3 20 feet.

The furnace comprises three doors (two arranged laterally and one at the discharge opening) which insure a ready view of the whole bath surface, thus facilitating the introducing of flux material discharging of slag etc These doors are distributed over the spaces between the electrodes. The three cast steel bottom electrodes are fitted into the floor from underneath while the whole of the furnace body otherwise is entirely disengaged Its center of gravity is so arranged that the furnace may tilt of its own accord only in a backward direction the platform acting as a stop so that even in case of failure in the working of the tilting device the steel will never flow out of the furnace of its own accord

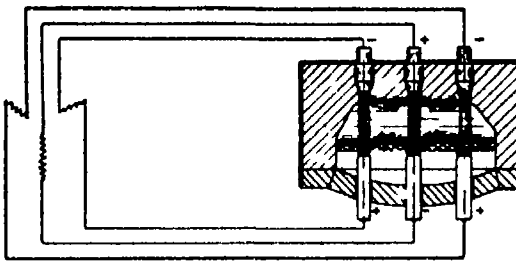


FIG 2—DIAGRAM SHOWING ARRANGEMENT OF ELECTRODES IN THE THREE PHASE CIRCUIT

Three carbon electrodes 6 56 feet in length and 0 82 foot by 0 82 foot in cross section enter the furnace through its walls These electrodes are arranged at the corners of an equilateral triangle being suspended from rails by traction cables and rollers Twelve flexible copper plates are used to supply current to each of the carbon electrodes Six cables from the main transformer and six cables from the booster transformer lead to each of the bottom electrodes the lower part of which is cooled by a common cooling water conduit Each of the carbon electrodes is surrounded by a special cooling box

The operation of the furnace is carried on as follows After making up in the furnace a wood or coke fire for starting the current is switched on so that the flux soon becomes conducting after which the coke is scraped off and liquid steel poured in Whenever the operation of the furnace is discontinued a similar process is resorted to the furnace being left filled with incandescent coke

The current consumption in the case of mild charges has been found to be about 1 700 to 2 000 kilowatt-hours for charges of five to five and a half tons thus working out at 300 to 400 kilowatt hours for each ton While this figure is relatively high it should be considered that mild charges naturally take a longer time to refine than hard charges Though moreover local conditions in the tests were as unfavorable as could be such charges have frequently been made with less than 300 kilowatt hours to the ton

No definite idea of the working expenses can so far be formed The first cost of the five-ton furnace was found to be about 12 000 marks, and that of the electrical equipment, exclusive of the transformer or generator but inclusive of cables, pole pieces, etc, about 15 000 marks A chief smelter, a smelter a boy and a man for regulating the electrodes were required to keep up operation The life of the lid was found to be six weeks.

* Stahl und Eisen, No. 38 1910.

The World's Lead Supply

After having passed in review the world's production in reserves in coal, iron and copper, Prof. J. F. Kemp, in his paper, "Geology and Economy," goes on to treat in the same way the case of lead We quote him in his own words

'Among the nations of the world the United States has become the chief contributor of lead and yields year by year proportions varying from 27 to 30 per cent of the total The next country is Spain with about two-thirds as much and Germany follows with three fifths

In this country the State of Missouri is the heaviest contributor and is responsible for practically 40 per cent of the total Idaho is next with about 30 per cent and Utah follows with 13 to 14 The Western lead all carries silver The precious metal is an important factor in the value of the product When we come to forecast the future it is not possible to see more than a few years in advance or to speak in more than a general way The miners would be glad to be assured of reserves of ore for a goodly period of years but it is seldom possible or practicable to demonstrate their presence Operations necessarily continue with a few years supply blocked out in advance of the actual mining and the hope is maintained that more will be found Very often the expectations prove justified We may therefore in a measure forecast future experience somewhat by the past In the Missouri lead region mines have been operated for forty or fifty years not on so large a scale at the outset as now but continuously For some years at least no change may be anticipated In Idaho the lead ores are now known to continue to depths of nearly 2 000 feet beneath the overlying surface and to be holding out without essential change in character. In Missouri however the mines never have been very deep that is over three or four hundred feet, and the compensation comes in wide horizontal extent.

Some of the old time heavy producers have greatly declined Nevada once an extremely important source of lead is now a comparatively small contributor. Colorado in former years our chief source has dropped to only a third of its one time yield and yet the total of the country has gone quite steadily on The fall in the price of silver was a hard blow to the Western lead miners and naturally not only cut off their profits but raised the necessary percentage of metal in the ore.

If we look ahead for a century or some such long period we may not feel assured that production can be maintained at present rates There may of course be new discoveries in lands not as yet fully explored Being distant from present centers of consumption as they necessarily would be their entry into the markets would imply higher prices so as to meet the charges of freight

On the other hand lead is a metal which oxidizes or changes very slowly In its applications in the metallic state it tends thus to accumulate unless lost in use as in the case of shot and bullets. It is extensively employed in the manufacture of paint and in this form is of course never recovered About 2 per cent of the entire output is destroyed to give us white and red pigments

It behooves us on the whole to be careful in the use of lead and to avoid when possible, its unnecessary sacrifice

Ionization in the Electric Furnace

An interesting apparatus was exhibited at the recent soiree of the Royal Society by Dr J A. Harker and Mr C G Eden In some experiments involving the treating of refractory oxides in the electric furnace some curious effects were noticed indicating pronounced differences in the chemical activity at high temperatures of the atmospheres of two different electric furnaces A miniature furnace of simple construction suitable for temperatures to 3 000 deg C, was shown working It consists of a tube of arc lamp carbon 14 millimeters external diameter, surrounded by a protecting sheath of pure lamp black, and heated by alternating current, passed through it from a small transformer Entering the interior of the tube at each end, and insulated from it, is an electrode of carbon One electrode is hollow so that an optical pyrometer can be sighted upon it the other is movable on a graduated scale A battery of variable E M.F and electric measuring appliances serve to measure the amount of current sent across the gap at any temperature In the larger furnace used, the resistance of the gap varies from infinity at ordinary temperature to an apparent value of less than an ohm at 2,200 degrees. At low temperatures such as 1,400 degrees a few volts give a "saturation current." At high temperatures the saturation current reaches 8 or 10 amperes. The phenomena are not those of an arc, and are unaltered by passing an indifferent gas through the furnace.

The Wastes of a Blast Furnace*

How They are Utilized

By Edward M Hagar, President, Universal Portland Cement Company Chicago

Until the last decade, practically the only utilization of the wastes or by products of a blast furnace was the use of a portion of the waste gases to raise the temperature of the incoming blast through heat ing the brick work in so-called hot stoves and in some cases a small portion of the power value of the gases was obtained by burning them under boilers to generate steam for driving the blowing engines

At the present time the calorific value of the waste gases is being utilized directly in gas engines for blowing purposes and for generation of electric power a considerable portion of the slag is used in the manufacture of Portland cement and the flue dust consisting of the finest ore and coke particles is being collected and converted so as to be rechargeable into the furnaces.

The aggregate saving or profits resulting from these three developments is a matter of millions of dollars per annum and in a modern blast furnace plant it would almost seem that pig iron was the by product and indeed the investment in the equipment to utilize those former wastes exceeds that of the blast furnace itself

The writer in his work has come in contact with these evolutions with plants in operation or under construction of a capacity to produce twelve million barrels of Portland cement per annum from slag and limestone using over one million three hundred thousand tons of slag in a year these plants being driven entirely by electric current generated by gas engines directly from the waste blast furnace gases the power requirements being forty thousand horse-power for twenty four hours every working day In one of the cement plants the first commercial method for reclaiming flue dust was discovered

By using the blast furnace gases directly in combustion engines after suitable washing to remove the grit, the power obtained from a given amount of gas is equal to at least two and one-half times that obtainable by burning the gas under boilers for generating steam for use in steam engines.

A modern blast furnace of the usual size with gas blowing engines and gas engines driving electric generators will provide sufficient gas to furnish seven thousand kilowatts electric power in addition to driving its own blowing engines

This permits the most modern steel works such as those at Gary Indiana to practically do away with the use of coal for power purposes operating the rolling mills by electric power from the surplus gases

The United States Steel Corporation of which the Universal Portland Cement Co is a subsidiary has already installed two hundred and fifty thousand horse power gas blowing and gas electric units which it can easily be figured displaces or saves the consumption of approximately a million tons of coal per annum as compared to the old fashioned method

With the modern high blast pressures and the use of fine Missabe ore the finest of the particles together with the coke dust, are blown out through the top of the furnaces and are caught in the flues dust catchers and gas washers

The iron ore in this dust amounts to fully three per cent of the total ore charged which aggregates the large amount of approximately a million and a quarter tons per annum in this country Until within a few years this dust has been thrown away or used as filling although containing about forty per cent metallic iron

For many years efforts were made to use this material by compressing it into briquettes but the cost of the operation together with the fact that the briquettes disintegrated and the dust was again blown out, led to an abandonment of the briquetting plants

The first commercially successful method of utilizing the dust was discovered by passing the material through the cement kilns at South Chicago Experiments showed that with the proper heat treatment, the coke dust could be burned off and the iron ore conglomerated into nodules or nuggets averaging over sixty per cent iron content. These nodules, when fed to the blast furnace, were easily and completely reduced. The fact that the sinter of the flue dust contains such a high percentage of iron and that all of the sinter is reduced, together with its physical shape assisting the steady movement of the charge downward in the blast furnaces, thereby preventing so-called slips, makes the sinter more valuable per ton than any ore.

It was necessary to derive mechanical means for preventing the accumulation of the sinter on the walls of the kiln Plants have been in operation for some years using this process with endless chains carrying scrapers constantly passing forward through the kiln and cooled in water on their return outside of the kiln

Recently other methods of utilizing dust have been devised which may prove successful commercially and the indications are that within a short time the greater portion of this former waste will be prevented

The development of the Portland cement industry in this country and the extension of its uses have been marvelous and the following table shows a remarkable increase in the production of Portland cement in the United States every year since 1895 when this country first reached the production of approximately one million barrels

Year	Production of Portland Cement in the United States	Production of Universal Portland Cement	Percentage of Universal to Total Amount of Portland Cement
	Barrels	Barrels	Per Cent
1895	990 324	——	
1896	1 543 023		
1897	2 677 775		
1898	3 692 284		
1899	5 652 266		
1900	8 482 020	32 443	0 38
1901	12 711 225	164 316	1 29
1902	17 230 644	318 710	1 85
1903	22 342 973	465 930	2 08
1904	26 505 881	471 294	1 78
1905	35 264 812	1 735 343	4 92
1906	46 463 424	2 076 000	4 55
1907	48 785 390	2 129 000	4 36
1908	51 072 612	4 535 000	8 88
1909	62 508 461	5 786 000	9 27
1910	73 500 000*	7 001 500	9 52

* Government estimate

It may be of interest to note the increasing percentage of the total American production shown by Universal Portland cement which is the only Portland cement manufactured in this country using slag as one of the raw materials With the new plant now approaching completion the aggregate production of Universal Portland cement in the Chicago and Pittsburg districts will amount to over one-eighth of the country's total Expressed in weight the output of the finished product will be over two million gross tons per annum Our plants in the Chicago district will consume all the available slag that is suitable for the purpose from an aggregate of nineteen blast furnaces in the South Chicago works of the Illinois Steel Company and in the Gary works of the Indiana Steel Company

Comparing the pig iron production and Portland cement production of this country in figures of long tons the percentage of Portland cement to pig iron in 1890 was six tenths of one per cent in 1900 ten and three-tenths per cent and in 1910 forty seven per cent The continuation of any such relative growth would mean that before 1920 the tonnage of Portland cement would considerably exceed that of pig iron I would hesitate however to predict that such would be the case

Portland cement is defined by the United States government as the product obtained from the heating or calcining up to incipient fushion of intimate mixtures either natural or artificial of argillaceous with calcareous substances the calcined product to contain at least one and seven tenths times as much of lime by weight, as of the materials which give the lime its hydraulic properties and to be finely pulverized after said calcination and thereafter additions or substitutions for the purpose only of regulating certain properties of technical importance to be allowable to not exceeding two per cent of the calcined product

From this definition it will be seen that the raw material for Portland cement is not limited to any particular form of material it may be made from any combination of materials that together furnish the proper elements In this country Portland cement is manufactured from a number of raw materials which, with a few exceptions, may be classed under four heads.

First. Argillaceous limestone (cement rock) and pure limestone.

Second. Clay or shale and limestone

Third Clay or shale and marl

Fourth Slag and limestone

In all cases the raw mixture is a combination of some form of clay and some form of lime and in the first and fourth classifications the clay materials contain some lime This simply reduces the proportion of lime material necessary for a proper mixture

In the manufacture of Portland cement from slag and limestone the molten slag flowing from the furnaces is granulated by a stream of water loaded into cars and transported to the cement plants where it is dried in rotary driers and receives the first grinding It is then mixed in automatic weighing machines with the proper proportion of ground and dried calcite limestone These are then ground together and burnt to a hard clinker at a temperature of nearly 3000 deg F in rotary kilns using pulverized coal for fuel

This clinker after seasoning is crushed and ground and mixed with a small percentage of gypsum to regulate the setting time The cement is ground to such fineness that ninety six per cent passes through a sieve having ten thousand meshes and eighty per cent passes a sieve with forty thousand meshes to the square inch It is then conveyed to the stock house for storage prior to shipment

It is necessary to use a flux in furnaces supplying slag for cement manufacture a pure calcite limestone The limestone burnt with the slag must also be a pure calcite stone It is also essential that the ores be of a uniform and proper character

Inasmuch as Lake Superior ores are noted for their remarkable uniformity of analysis the resultant slag obtained from the use of these ores and a pure calcite limestone is more uniform in its analysis than any form of natural clay deposit used in the manufacture of Portland cement and the variation in the proportions of the two raw materials used in the manufacture of Portland cement from slag is less than those of any other materials mentioned above

In addition the opportunity for analysis and selection of the proper ingredients through the use of an artificial material is a great advantage as compared to the necessitous use of natural materials just as they are found with their variations in analysis at different depths

In the intense heat of the kiln under the influence of the oxidizing flame any sulphides in the slag are completely burned out.

The rotary kiln commonly used ten years ago was sixty feet long and six feet in diameter This has gradually been increased in length and diameter until the modern kiln is one hundred and forty to one hundred and fifty feet long and eight to ten feet in diameter and there are a few even larger kilns in use Kilns are usually set at an incline of three quarters of an inch to the foot With the lining and contents the modern kiln weighs one hundred and fifty tons and in revolving upon two bearings presents interesting constructional features

In the case of the plant at Buffington Indiana using twenty six thousand horse power situated between South Chicago and Gary Indiana electric power is supplied at twenty two thousand volts from the steel works at these points Each piece of machinery is driven by its individual motor supplied with alternating current at four hundred and forty volts The high tension line is connected through the cement plants and the gas engines at these two steel works fourteen miles apart operate continually in parallel This enables the cement plant to draw its power from either source or from both sources at the same time as may be desirable It has happened that one of these works has supplied power to operate the cement plant and furnished additional power at the same time to the steel works at the other end of the line

The method of manufacture above described is the standard method of manufacturing Portland cement from natural deposits and the finished product differs in no way from other Portland cements in chemical analysis fineness specific gravity color nor in the operation in practical work It has no peculiarities whatever and has no limitations as to its applications There is no difference from the chemist's point of view between the manufacture of Portland cement from natural deposits such as limestone and clay or shale and its manufacture from limestone and slag Slag is really a mixture of the clay from the ore with the lime content of the stone used as a flux in the furnace

Our method of manufacture of Universal Portland

* Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

cement does not embody any real invention nor is it based on any patents It is simply an adaptation to an artificial raw material of the regular Portland cement process formerly applied only to natural deposits

True Portland cement in which slag is used as one of the raw materials should not be confused with Puzzolan or so-called slag cements which are simply mechanical mixtures of slag and slaked lime ground together without burning Such cements are suitable only for use under ground and in moist locations

The manufacture of Puzzolan cements in this country has practically been abandoned

The remarkable growth of the Portland cement industry is not equalled by any other manufactured article This is due to the economy durability and plasticity of cement and concrete work While large engineering work, such as dams, bridges, and heavy reinforced concrete buildings, consume large quantities of cement the bulk of consumption at the present day is in a multitude of small uses It takes an average shipment of only five barrels a day to take care of the average customer of a large cement company

For example, there is a steady increase in the application of cement to new uses on the farm, such as silos, fence posts, barn floors feeding floors watering troughs corn cribs etc There as elsewhere concrete is rapidly displacing all forms of wood construction this process being hastened by the continually advancing cost of lumber

Beautiful effects are now being obtained in concrete surface finishes and its use in decorative work is advancing rapidly

The use of Portland cement will continue to increase until the campaign of education of the small user has reached its finality In this direction a great work is being done to educate the general public in the proper use of cement by individual manufacturers, by the Association of American Portland Cement Manufacturers, and by the cement shows which are given in several of the largest cities every year

In conclusion it will be seen from the foregoing that most of the problems of utilization of wastes or by-products of the blast furnace have been solved and that these solutions in addition to being highly profitable, are powerful factors toward the conservation of our natural resources

Portland cement manufactured from slag, to a large extent, replaces wood the waste gases displace coal, and reclamation of the flue dust conserves the deposits of iron ore

Determining Aeroplane Altitudes*

How a Machine's Height is Measured

By Henry Harrison Suplee

MEASUREMENTS of altitude are usually more difficult of precise determination than those made at or near the surface of a comparatively level country This is evident in connection with the frequent revisions which have to be made of the altitudes of mountain peaks and it becomes especially apparent when the true height attained by an aeroplane is to be determined

The early performances of flying machines were comparatively limited so far as altitude was concerned the height above the surface being little more than was necessary to insure safe clearance above trees buildings and similar obstructions It is only within the past year that altitudes of several thousand feet have been attained but since the aviators have succeeded in acquiring greater control over their machines and have themselves discovered that no serious difficulty attends the conduct of flights in the upper air there has arisen a competition among sporting airmen to secure the record altitude which demands some reliable method for measurement of the true position above the surface of the earth Apart from the desirability of determining the correct height attained in any such competition it is also extremely important to be able to measure the correct position of an enemy in the air as soon as the aeroplane enters the domain of warfare The range must be obtained if the special aerial guns are to do effective work while knowledge of the true altitude is also most desirable in connection with the work of the scouting aviator

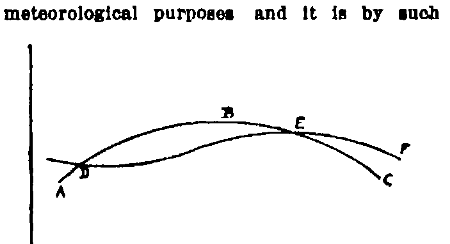
Several requirements must be met in considering satisfactory solutions of the problems connected with aerial altitude measurements Broadly two fundamental methods have to be considered one in which the apparatus employed is carried in the aeroplane itself the other in which the measurements are made by the use of instruments observing the flying machine from the ground These again may be divided into methods which enable the altitude to be determined immediately and continuously and those which require subsequent computations to be made from the observed data

The older aeronauts usually depended upon the barometer as an indicator of altitude and with the sustaining power of a large balloon and the opportunity afforded of consulting such an instrument carefully a certain degree of precision was obtained especially when a high grade mercurial barometer was carried and simultaneous readings were taken on the surface of the earth Even with a carefully calibrated aneroid compared with a standard instrument immediately before and after the trip the altitude attained might be fairly well determined provided the rate of ascent and descent of the balloon was not too rapid

PHOTOGRAPH OF ISLE ST LOUIS TAKEN FROM BALLOON

The known distance between river banks and the known focus of lens enable altitude to be computed

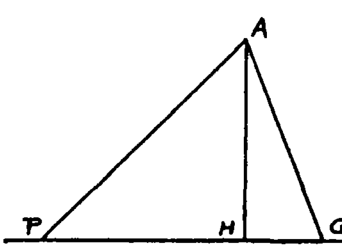
In the case of the aeroplane however the conditions render it impracticable to use a mercurial barometer while the demands upon the operator's attention preclude the possibility of visual readings and records Reliance therefore has to be placed upon the recording aneroid barometer similar in general construction to the instruments generally employed for meteorological purposes and it is by such apparatus that most of the published altitudes attained by aeroplanes have been determined



CURVES SHOWING LAG OF BAROGRAPH RECORD

Records of this kind however, must be accepted with caution and should be carefully checked, whenever possible, because of the conditions under which the instruments are obliged to act are hardly conducive to a very high degree of precision.

A brief examination of the construction and action of the aneroid barometer will show why this is so The aneroid barometer is really a special form of pressure gage, intended to measure external pressures generally less than the ordinary atmospheric pressure at sea level The pressure gage as usually employed in engineering work is employed to determine pressures maintained in closed vessels such as steam boilers reservoirs of compressed air or of water under pressure and the like and it is not difficult to make suitable connection and lead the pressure fluid into some kind of a closed chamber in the instrument and utilize the dilatation or other movement of the walls of the chamber to indicate the variations in pressure In the case of the barometer however the pressure fluid is the external air and the arrangement of parts must be practically reversed This is effected by employing a small chamber usually cylindrical in form, somewhat like a short drum the top and bottom being corrugated in order to permit a certain amount of movement If the air be exhausted from such a chamber the tendency will be for these corrugated ends to collapse together under the external pressure of the air and if this tendency is opposed by a spring of sufficient strength to hold the ends apart the apparatus will be in equilibrium so long as the pressure of the external atmosphere remains constant If the external pressure increases the corrugated ends will move together while if the pressure decreases the force of the spring will pull them further apart. The combination



TRIANGULATION METHOD FOR DETERMINATION OF ALTITUDE

therefore will respond at all times to the variations in atmospheric pressure It is evident that the amount of movement permissible is limited by the elasticity of the metal and by constructive details and that it is in all cases very small

It is necessary therefore to use some method of multiplying the motion in the vacuum box as it is termed In the ordinary dial barometers of the Naudet type this multiplication of motion is effected by the combination of levers and of watch-chain, often visible through the opening in the front, while in the recording barometers of the Richard design recourse is had to the use of several vacuum boxes built up together in such a manner as to secure the accumulated movement of all, this increased movement being also multiplied by leverage A pencil attached to the end of the lever enables the vertical movement to be recorded upon ruled paper, and if this paper is kept in motion at right angles to the pencil movement by means of clockwork a curve of pressures will be automatically described It is an instrument of the latter type which has been used in most of the recent altitude flights of aeroplanes.

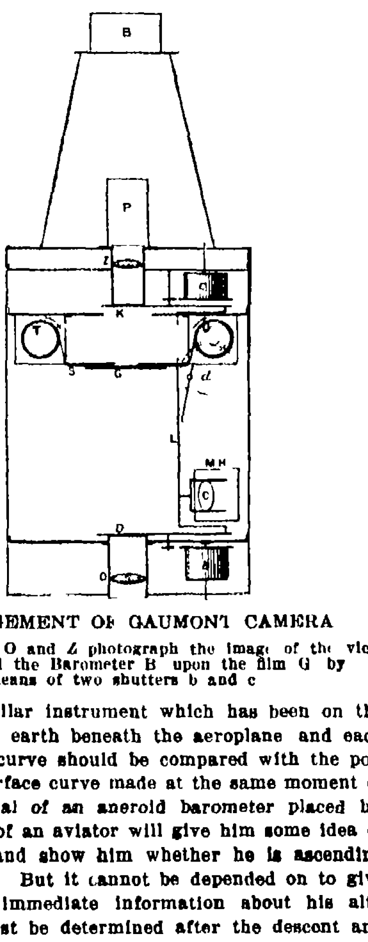
The great difficulty in obtaining reliable records with such a barometer lies in what may be termed its "lag." As will be perceived from its construction a certain amount of time is required for the mechanism to respond to changes in external pressure. This lag is due not only to the movement of the vacuum box itself, but also to the frictional resistance and inertia of the multiplying mechanism—and, indeed, it is principally caused by the latter The result is that the instrument does not respond quickly enough to follow

* Reprinted from Cassier's Magazine

rapid changes in altitude. This may readily be demonstrated by carrying an aneroid barometer in the hand while making a rapid ascent in the express elevator of a tall building. The pointer will be seen to fall for some little time after the elevator has reached the top of its run showing that an immediate reading would have been erroneous. In mountain ascents and similar measurements this error is eliminated by giving sufficient time for the instrument to catch up with the pressure changes and under such conditions very precise altitude determinations may be made, but this is impracticable in the case of the aeroplane.

The extent to which this lag may affect the indications of a recording aneroid barometer is seen in the diagram. If the curve *A B C* indicates the actual pressures of the atmosphere and the transition be rapid the recording barometer which may be correct at the point *D* will not rise quickly enough to trace the true curve and will still be rising when the correct curve has begun to fall so that the record on the paper of the instrument will be something like *D E F* different both in form and position from what it should be. Such a deviation from the truth will be greater or less according to the rapidity in the change of altitude. In general it may be accepted that the recording barometer as at present constructed may show the correct height of the aeroplane by which it is carried if the machine soars at a fairly constant height for a moderate time—probably half an hour would be ample—but that under more rapid altitude changes it will indicate a lower altitude than the true one.

In any case it is impracticable to obtain a reliable determination by the direct reading of the instrument alone. The reading should always be compared with



ARRANGEMENT OF GAUMONT CAMERA

The two lenses O and Z photograph the image of the view beneath and the Barometer B upon the film G by means of two shutters b and c

that of a similar instrument which has been on the surface of the earth beneath the aeroplane and each point on the curve should be compared with the portion of the surface curve made at the same moment of time. The dial of an aneroid barometer placed before the face of an aviator will give him some idea of his altitude and show him whether he is ascending or descending. But it cannot be depended on to give positive and immediate information about his altitude; this must be determined after the descent and comparison with the station barometer.

It is true that there are certain types of aneroid barometers notably the improved instruments of the Goldschmidt pattern, which are notably free from lag owing to the direct connection between the vacuum box and the indicating arm but these instruments have as yet, not been made in the recording form and require careful and precise ocular readings to be taken and the altitude subsequently computed. While especially well adapted for mountain service and for the measurement of altitude determinations upon the surface of the earth they have not as yet been adapted to aeronautical purposes. It is probable that a barograph combining the accurate indications of the Goldschmidt barometer and the convenience of the well known disk recording pressure gage may be constructed for this purpose.

The suspension of a barograph when carried in an aeroplane is a matter which demands attention. Vibrations in themselves are rather beneficial than otherwise in the use of an aneroid barometer and it is desirable that the ordinary instrument should be tapped before a reading is taken, in order that the frictional resistance of the pivots and other working parts may be overcome. The continual trembling of the aeroplane motor, however, introduces vibrations into the record curve, which may become periodical and excessive unless the instrument is carefully suspended. M Latham suspends his barometer from his neck but a better plan is that devised many years ago by the late Col Renard the case of the barograph being placed within a bamboo cage and held suspended in space by a number of rubber bands. It

PHOTOGRAPH TAKEN IN GAUMONT CAMERA, SHOWING BAROMETER DIAL UPON VIEW

has been shown that an instrument thus suspended may be allowed to drop from a height of 10 or 15 feet to the ground without injury. Barographs fitted in this manner have been successfully used upon the *ballons-sondes* or free exploration balloons sent out for meteorological investigations.

Optical methods employed from the aeroplane itself are necessarily limited since they usually demand more attention than can be given by the operator himself and require the service of an independent passenger. The principle is that of the well known artillery range-finder the observer in the aeroplane sighting upon two points on the ground and reading the corresponding distance on the scale of the instrument whence the proportionality of similar triangles gives the altitude or the scale of the instrument may be so graduated as to enable the altitude to be read directly.

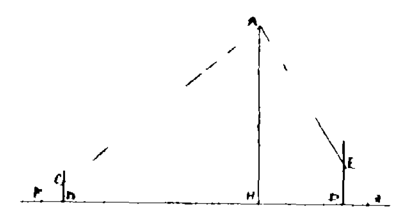
This principle however may be still further extended by the use of the apparatus already fully developed for the operations of photogrammetry or photographic surveying.

The idea of taking photographs from a balloon appears to have originated with Nadar as long ago as 1855 but it was not until the perfection of the gelatino bromide dry plate and the consequent possibilities of instantaneous photography that practical results were obtained. Attempts were made in France in 1878 by Dragon and by Triboulet and in 1880 by Desmarets while in 1883 some very successful photographs were taken in England by Shadbolt. Photography from balloons thus became recognized as a valuable adjunct especially in connection with military observations and its possibilities have by no means yet been exhausted.

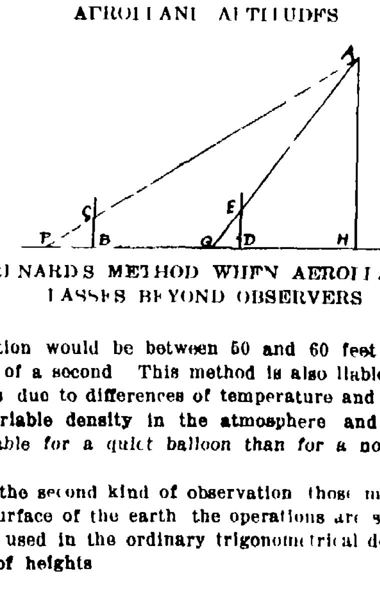
The excellent work which has been done by French topographers notably by Col A Laussedat using cameras of special design arranged so as to enable several correct perspective views to be combined into

clearly marked monuments on the field furnishes the necessary information and the proportion between the true distance between two stripes on the field and their distance on the photograph will give the relation between the focus of the lens and its height above the ground. When no predetermined base is visible it may still be possible to find out subsequently the dimensions of some building or other object in the picture and thus enable the altitude to be computed. Several years ago M Gaumont devised an ingenious combination of camera and aneroid barometer so arranged that the dial of the barometer was photographed upon each picture thus furnishing a record of the altitude at which each negative was taken. This method involves the general objections to the use of the aneroid which have already been mentioned but the plan has wide possibilities in connection with probable improvements in barometers for this purpose.

An ingenious plan which has been suggested for measuring the altitude of an aeroplane and which while it requires the services of an independent operator demands no other apparatus than an accurate stop watch is the acoustic method. Any sharp sound such as a quick whistle or a report which may be differentiated from the noise of the machine itself will be returned to the ear of the operator in the form of an echo from the surface of the earth. If therefore the time elapsing between the sound and the echo be noted the corresponding distance may be estimated from the known velocity of sound. Taking the velocity of sound at 1 100 feet per second or a little more than 100 feet for a tenth of a second and remembering that it is the double distance going and returning which is thus computed the error of ob



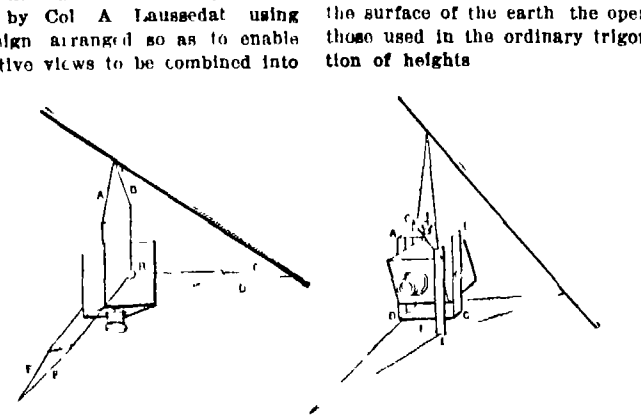
RENARDS METHOD FOR DETERMINING AEROPLANE ALTITUDES



RENARDS METHOD WHEN AEROPLANE PASSES BEYOND OBSERVERS

servation would be between 50 and 60 feet for one-tenth of a second. This method is also liable to variations due to differences of temperature and of layers of variable density in the atmosphere and is more available for a quiet balloon than for a noisy aeroplane.

In the second kind of observation those made from the surface of the earth the operations are similar to those used in the ordinary trigonometrical determination of heights.



METHODS OF SUSPENSION OF CAMERA FROM AEROPLANE

a single topographical map shows what may be done when a direct plan can be photographed from above. Already the camera has been arranged to permit photographs to be taken from observation kites and a similar apparatus is adaptable to the aeroplane.

By having a ruled screen placed within the instrument so that the lines are photographed upon the film at the same time as the surface of the earth beneath the scale of the picture may readily be determined in connection with the known focal length of the lens and thus the only element required to be known is the true dimensions of some object in the picture. In the case of the altitude record trials the use of certain

Thus if an aeroplane be situated at *A* and two observers at *P* and *Q* at the extremities of a base line of known length and simultaneous observations are made of the angles *A P Q* and *A Q P* the triangle will be completely determined and the height *A H* may be computed. If the observers are directly beneath the aeroplane the altitude will be obtained very simply but this is rarely the case. It will therefore usually be necessary to make three simultaneous observations from as many known points from which the true height may be obtained.

At the Harvard Boston Aero Meet in September 1910 trigonometric measurements were made with a

base line of somewhat more than 6 000 feet. The operators were provided with standardized watches to enable tally to be kept of the observations and with head and breast attached telephones to enable the word to be passed for the moment of the simultaneous observations. Since transit instruments were employed it was possible to measure both vertical and horizontal angles and thus the results were obtained with but two observing stations. For ordinary angular measurements of this sort the sextant has also been employed but the precision is necessarily lower than with the transit.

Another method suggested by Commander Paul Renard may be applied under certain conditions. Two observers are placed at points P and Q the distance P Q between them being known and it is also being known that the flight of the aeroplane will pass over some point vertically over the line between P and Q. The two observers are furnished with instruments which enable them to measure the apparent height. In the absence of sextants or other instruments of precision a simple substitute may be found in the form of rods placed at B C and D E these being erected as nearly vertical as possible and at points at which the distances B–P and D–Q are known. These rods should be graduated so distinctly as to be easily read by the observers and it is essential that P B and D Q should be on the same alignment. The observers are to be instructed to watch for the passage of the aeroplane and to read the apparent point at which it crosses the graduated rods at the moment when it passes over the base line. With these readings and the knowledge of the distance between the two observers the altitude of the aeroplane may be computed as follows. From the two sets of right angled triangles we have

$$\frac{P\,B}{C\,B} = \frac{P\,H}{A\,H}$$

and also

$$\frac{Q\,D}{E\,D} = \frac{Q\,H}{A\,H}$$

By adding these two equations together we get

$$\frac{P\,B}{C\,B} + \frac{Q\,D}{E\,D} = \frac{P\,H + Q\,H}{A\,H} = \frac{P\,Q}{A\,H}$$

In this formula we have the quantities P B Q D and P Q already known while the single unknown which may thus be determined is the altitude A H. This method it will be observed is independent of the particular values of the horizontal distances H P and H Q—that is the aeroplane may pass anywhere over the line between the two observers provided the corresponding readings on the two graduated rods are correctly taken. It is desirable however that the aeroplane pass between the observers although readings may be taken if it should pass beyond them as shown in the figure. With experienced observers this will give fairly good results since the men will secure approximately simultaneous readings. The principal defect is that it gives the height over some undetermined point H and hence it is well if possible to have the whole system arranged upon a fairly level plain.

When a trial for an altitude record is made upon this plan the aeroplane may circle above the base line and its height taken every time it cuts across the line the observations being numbered to enable the proper ones to be paired.

In many cases especially in warfare it is the distance between the observer on the earth and the machine in the air which is desired. This is really a problem in range finding, and the principles are [illegible] known.

At the camp of Chalons the Boushier telemeter [illegible] used with a fair measure of success. The instrument consists of two telescopes, of which the objectives are fixed at one meter apart and the images brought together by reflectors, so that measurement is made of a very acute triangle the aeroplane being at the sharp apex opposite the base of one meter.

It will be seen that at the present time there is no method which is entirely satisfactory for general use. Trigonometrical observations from the ground, while the most accurate require much previous preparation practicable only during some exhibition or sporting event and possibly capable of permanent installation in important fortresses liable to attack, but otherwise inapplicable for lack of time and need of suitable apparatus.

The photographic methods require in general the services of an additional operator although it is possible that an automatic device may be produced. In any case it does not furnish its report until after the flight is over and the film developed and hence its usefulness is limited to the production of a subsequent record of the trip. It may well be investigated however in connection with the substantiation and verification of altitude records made by other methods.

There remains the barometrical method and, while this is at present lacking in precision it offers the greatest opportunities for improvement and development. In view of the high degree of precision attained in the determination of mountain altitudes by aneroid barometers of the Goldschmidt type it seems altogether possible that some improved variety of barograph will be produced in response to the demand which the aeroplane is making.

Sugar Refining*

The Processes of Manufacture

By W D Horne

Just as sugar made from the cane appears first to have been used in the Orient and to have followed a westerly path so we find the art of refining had its origin in the East and progressively traveled westward. Although the sugar cane was in use in India as early as the fifth century B C we learn of refining having been practiced first about 500 A D in Mesopotamia. A large trade in refined sugar gradually developed between the Orient and Europe and in 1470 a certain Venetian was awarded a government payment of 100 000 crowns for discovering a process of refining sugar which was from that time extensively carried on in Venice. In the sixteenth century Antwerp led in the sugar trade in Europe and in the refining industry. England began refining sugar in 1544 and gradually gained the supremacy over the other European countries in the industry. With the development of refining in Europe the price fell from two shillings per pound in the thirteenth century to four pence per pound in the sixteenth century. This undoubtedly was partly due to the general introduction of the sugar cane into the West Indies from 1510 to 1650 and the consequent enormous production of sugar and its ever growing commerce.

As early as 168[illegible] there was a refinery in New York city and by 17[illegible] New York Philadelphia and Boston refined about 1 [illegible]00 000 pounds of sugar yearly out of the 60 000 000 pounds which was annually consumed being about two per cent of the entire amount. Refined sugar was heavily protected by duty and sold at [illegible]0 cents per pound. By 1860 there were forty one refineries in the United States producing $42 000 000 worth of sugar annually. Now there are about half as many refineries turning out three million tons of sugar annually worth about $ [illegible]00 000 000.

In 174[illegible] Marggraf succeeded in obtaining 6.2 per cent of sugar from beets and Achard established the first beet sugar factory in Austria in 1769. Napoleon to encourage the industry on account of the difficulty in obtaining sugar because of the blockade of the French ports during the wars heavily subsidized the industry in France about the beginning of the last century. It gradually spread over Europe. The first experiments in beet sugar manufacture in the United States were made in 1830 and again some beet sugar was made in California Illinois and Wisconsin during the period from 1863 to 1876. Claus Spreckles built a factory in 18[illegible]0 at Alvarado Cal which was the first to meet with pronounced success. The industry has developed considerably since then until there are now sixty four factories located principally in the western States and Michigan with a total output last year of 457 000 tons being 13.92 per cent of the consumption of the country. By 1900 the production of beet sugar had so increased that it had grown to be 60 per cent of the world's sugar supply.

In 1910 11 the world's sugar supply will be 17 000 000 tons—50 per cent cane and 50 per cent beet. Sugar is produced also in small quantities from the sap of the date palm in some eastern countries. Prolonged attempts were made in this country some fifteen or twenty years ago to produce sugar from sorghum but without success as the dextrinous bodies in the sorghum juice prevent large quantities of the sucrose from crystallizing and this plant is now used exclusively for the manufacture of syrup. The annual production of maple sugar in this country amounts to 6 000 tons but as maple sugar owes its principal value to its pleasant flavor rather than to its sweetness it is always sold in its raw state as refining it would rob it of half its present value and render it impossible of competition with cane or beet sugar. Milk sugar is produced to some extent and used always refined for medical purposes principally.

Sugar refining consists essentially in the purification of the crude crystalline material through the well known process of recrystallization. To this we can add the second process of absorption of impurities by means of bone black first introduced by Derosne in 1812. By this means is affected a direct separation of impurities from the sugar solution and a large removal of the coloring matters allowing of the more easy production of perfectly white crystals. While the process is relatively a simple one and perhaps more mechanical than chemical in its nature the enormous consumption of sugar in the country and keen competition in manufacture have led to the establishment of very large and elaborately equipped plants for the conduct of operations where every economy of procedure is carefully observed. The great amount of capital involved in erection and maintenance of such plants together with the highly developed technique required for their operation has tended to keep the business in relatively few hands and to render it a dangerous enterprise for any but the most thoroughly equipped to venture upon. The sugar refineries of the country are in a few spots—New York Philadelphia Boston New Orleans, San Francisco and Baltimore containing practically all of them. In 1910 the country consumed 3,350,355 long tons of sugar practically all being refined. Of this amount 333 006 tons were cane sugar raised in Louisiana and neighboring States. 457 000 tons were beet sugar raised and refined during the process of manufacture in our western factories. 2 472 756 tons came from our insular possessions and Cuba and 73 393 tons came from other foreign countries. We imported practically no beet sugar and we exported practically no sugar at all. With the exception of Great Britain the United States leads the world in the consumption per capita of sugar this being 81.6 pounds per person. Most of this goes into direct use for household purposes and yet enormous quantities are consumed by manufacturers of confections preserves condensed milk as well as by canners of fruit ice cream makers soda water fountains and many other users.

As will be seen the natural location for a sugar refinery is on the water front where it can more economically receive and unload the great cargoes of sugar and of coal which come to it almost daily for a modern refinery melts from a million to three or four million pounds of sugar per day. The economical handling of this vast amount of raw material and the successful guidance of so much organic matter in solution at high temperatures through long and complicated processes without fermentation, decomposition discoloring or waste is no mean accomplishment, but as in every other instance of manufacture the whole matter has been worked into a routine which once properly installed, almost takes care of itself. As the sugar whether in solution or later in granular form has to pass through many operations in a continuous stream as it were, it is thus found advantageous to have the units of a sugar refinery many stories high so as to take advantage of gravity to pass these solutions from place to place or in delivering the dryer material from one department to another. This holds true equally of the bone-black and we find the char house is usually a tall building in close proximity to the sugar house itself. In many instances the boiler house also has its coal bunkers in the upper story, allowing the fuel to feed by gravitation into the fire room or even upon the grates themselves. The high cost of real estate in cities also makes it advisable to extend upward rather than laterally. Each sugar refining plant will be found to have a large dock department for the receiving, weighing and storage of raw sugar; a boiler house for the generation of steam for power and evaporation, a wash house for the so-called washing of raw sugars, the pan house for boiling grain-

* Yale Scientific Quarterly

[illegible] and other processes of manufacture of dry sugars a char house for the accommodation of the bone-black filters kilns for the re-burning of the char etc., and usually a warehouse for the storage and shipment of refined products. These departments are not always built separately and frequently more than one of them will be found in the same building

Somewhat different processes are used for the refining of beet and of cane sugar but the difference consists principally in the method of defecation or clarifying the original raw sugar solution of its suspended impurities and part of its coloring matter In either case the first operation is the unloading weighing and storage of the raw sugar whether in bags baskets mats, hogsheads or in other packages in proximity to the melting department A portion of the sugar is usually taken direct from the scales to the wash house, where the sugar is raised by a bucket elevator to an upper story and mixed with a low grade syrup while passing through a conveyor to the raw sugar mixer The magma of raw sugar and syrup is fed from the mixing tank containing revolving arms into centrifugal machines which purge the syrup from the sugar in a few minutes Water sprinkled on effects the final washing giving a sugar of high purity and a low syrup This sugar is dissolved in a round melting tank with revolving arms in hot water to a density of about 30 Beaumé pumped into blow ups treated with a very small amount of acid calcium phosphate and made slightly alkaline with milk of lime Such a solution would boil at about 217.5 deg F and its temperature is next raised to something under 200 deg F whereby tricalcic phosphate is precipitated entangling the suspended impurities and also removing possibly by precipitation some of the coloring matter The lime has the effect of precipitating some of the gums and the heat at the relatively slight alkalinity precipitates most of the albuminoids. This process is applicable to cane or beet sugar or to a mixture but in defecating beet sugar alone it is sometimes customary to add a few tenths of a per cent of caustic lime precipitating this with carbon dioxide which precipitates suspended matters and largely removes the color In either case the solution must be mechanically filtered This is commonly done through cotton twill bags inclosed in woven sheaths These are called Taylor filters *In the case of beet solutions the* filter press is sometimes used but this is not applicable to cane sugars which are gummy and sticky and clot the filter press Beet sugar solutions are sometimes treated with sulphur dioxide after this preliminary alkaline defecation and again filtered in presses in a very faintly alkaline or neutral condition The filter bags after becoming nearly exhausted are allowed to drain during several hours are washed with hot water several times allowing to drain between times and are removed from the closed iron tanks in which they hang for washing They are turned inside out and rinsed in several waters passing through wringers between them The muddy water thus obtained still contains some sugar and is pumped through filter presses the sugar of the clear filtrate being recovered The press cake containing very little sugar is discarded

The clarified solutions are next filtered through bone-black contained in cylindrical filters or cisterns The liquor gives up the greater part of its color and a less per cent of its ash and organic impurities to the bone black and is collected in storage tanks according to color and purity Lower grade solutions of greater color follow the washed sugar solution on the char so that the last filtrate from the char is pretty dark in color and much lower in purity

The char filtered liquors pass to the vacuum pan holding about 1 000 to 2 000 cubic feet where it is boiled to grain and concentrated to a low water content.

This magma is dropped into the mixers or crystallizers from which it passes to the centrifugal machines, where it is purged and washed with a spray of clear water sometimes followed by a spray of blue water *formerly colored* by ultramarine which of late years has been replaced by harmless aniline colors prescribed by the government since the pure food law put its ban on ultramarine as a mineral substance not to be allowed in sugar products The syrups can again be boiled in the vacuum pan to produce granulated sugar and when the impurities and color accumulate enough the syrups are used for yellow sugars

The moist sugar from the centrifugal machines containing a small per cent of water is passed through nearly horizontal revolving drums containing longitudinal shelves projecting inward which have the effect of picking up the sugar and sprinkling it through the current of warm air which is drawn through the opposite direction

The sugar thus dried next passes through revolving screens which separate it into different grades according to the size of the crystals giving rise to granulated sugar to be bagged or barreled

In making cube sugar some of this moist granulated sugar from the centrifugal is pressed into cubical blocks by an ingenious machine and gently dried in ovens during a few hours Cut cube sugar was originally made by draining the magma or boiled mass of sugar in conical molds for about two weeks with occasional washing by means of pure sugar solution sawing the dried cones into disks and cutting these across into cubes A modified process of this kind is in use in Europe and to some extent in this country in which the conical molds are supplanted by rectangular frames which are purged in centrifugal machines in minutes instead of weeks

Yellow sugars are made from low testing syrups which are boiled in a vacuum pan and contain smaller softer crystals than higher grades of sugar with considerable amounts of adherent mother liquor

To return to the bone-black this is washed down by hot water after the last sugar solution sinks below its surface and is thus freed from the sugar Certain mixing of the water with the sugar solution is inevitable *giving rise to a zone of sweet water* As the water begins immediately to dissolve the impurities which the char had just absorbed *from the impure* sugar solution passed through it this sweet water contains impurities along with the sugar and has to be separated from the main filtrate and treated by itself The sugar washes out faster than the impurities however and when most of the sugar has been removed the stream of outgoing water is turned to the sewer and continued until the char is pretty nearly free of what water can remove The bone black is then drained emptied from the filter by gravity upon a dryer on the floor beneath through which it passes to the kilns These are furnaces provided with internal iron pipes through which the char passes *By proper regulation of the flow of the* char through these retorts its temperature is kept at a point which subjects the impurities still *remaining* in it to destructive distillation Moisture ammonia carbon dioxide and other gases are given off some of which are highly inflammable leaving in the char a small residual amount of carbon The char after cooling is then ready for use again and this entire cycle of operations is repeated

When the carbon accumulates to such an extent as to choke the pores of the bone black the decolorizing power of the char diminishes so that finally it must be discarded Of late years this trouble has been *obviated by the introduction of the* Weinrich system of de carbonization in which the char is passed through a roaster very much like the granulator before described and heated on the outside by direct fire to a suitable temperature The air admitted suffices to burn off the impurities without attacking the carbon of the char itself in any marked degree By this means char can be kept at a high point of efficiency for a considerably longer time

The large amount of heat passing away from the char filters in the hot wash water is recovered by passing this water through tubulated heat economizers in which the incoming city water passes in the opposite direction absorbing the heat of the outgoing water

Water for sugar refining should be as soft as possible and as free from sulphates iron color and suspended matter as can be

The sweet waters from the char are evaporated in multiple effect evaporators and usually mixed with other low grade solutions

Fuel is an important matter in sugar refining large quantities being used to generate steam for *power purposes evaporation and heating* This in large part explains why sugar is not refined where the raw product is made the fuel cost being prohibitive

The laboratory organization in a sugar refinery is a matter of great importance It is the laboratory's function to keep track of the quality not only of the raw and finished material but also of the material in process of refining not only to show the efficiency of each process but to enable the most economical and expedient combination of the various liquors syrups and other solutions throughout the process of refining so as to prevent unnecessary work and to indicate the most advisable method of handling All raw sugars have to be analyzed in considerable detail a close watch is kept on fuel variations in the water supply must be noted finished products must be kept up to the mark and waste products must be carefully checked up to avoid excessive loss New processes have to be devised to meet varying condition and experimental work must always be pursued to keep up with the latest improvements and discoveries in the art

The routine must go on day and night without cessation and all chemicals apparatus and other appliances must be properly standardized and those standards maintained *Analytical processes* have to be investigated and tests devised for new needs *many materials entering into use in a large factory* have also to be subjected to occasional tests or analyses and competent advice has to be given as to the desirability of new methods or processes suggested from whatever source

All this calls for an elaborate competent and smooth running chemical organization The routine tests principally of purities are conducted by young men carefully trained in this work and provided with every possible facility for its accurate and speedy accomplishment In the laboratory many tests are made on char samples and wash water daily all raw materials and waste products all miscellaneous sugar samples *as those involved in stock taking* and so on

The laboratory also keeps careful statistical records of all its various work and compiles elaborate monthly and yearly statements covering all these tests The laboratory should be provided further with a good general chemical library and ample files of sugar journals as well as those of more general nature A good laboratory should lead the work of the house rather than follow it by showing the way over difficulties that are from time to time bound to spring up by inventing and elaborating new processes of more economical work by keeping in touch *with the outside world and in general by assisting* a smooth running of the entire enterprise

A Graphical Solution of the Quadratic Equation*

By Albertus Darnell

Prof Carl Runge of Göttingen among other applications of graphical methods, mentions a very interesting solution of the quadratic equation Prof Runge it will be remembered was Kaiser Wilhelm Exchange Professor at Columbia University during the past year

First consider the following graphical calculation for determining a line which shall represent the value of $f(x) = a_0 + a_1x + a_2x^2$ for some particular value of x.

Lay off $AB = a_0$, BC perpendicular to AB and equal to a_1, CD perpendicular to BC and equal to a_2. Now make DE equal to the unit of measure, EF perpendicular to DE and equal to the value of x for which we wish to compute the value of $f(x)$ Draw GH perpendicular to DF AH is the linear representation of $f(x)$ when x equals EF

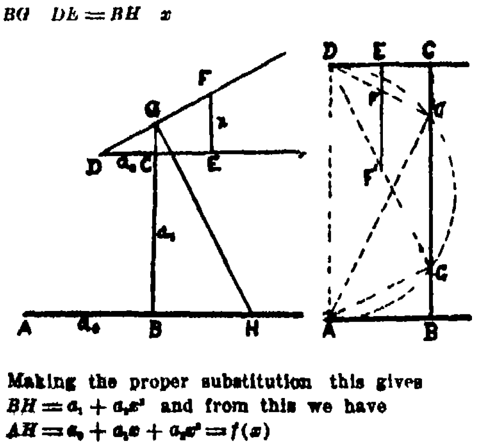
It is obvious that the triangles of the figure are similar. Therefore we have

x $CG = DE$ a_2

Remembering that DE is the unit this gives $CG = a_2x$ and from this we have

$BG = a_1 + a_2x$

BG $DE = BH$ x



Making the proper substitution this gives $BH = a_1 + a_2x^2$ and from this we have $AH = a_0 + a_1x + a_2x^2 = f(x)$

If the value of x had been so chosen that the point H had fallen at A we should evidently have had a value of x satisfying the equation $f(x) = 0$ This reduces the solution of the quadratic to the problem of constructing a right triangle on AD as hypotenuse with the vertex of the right angle on BC

The next figure shows the application of this method to the equation $2 + 5x + 2x^2 = 0$

EF and EF are respectively the roots $-\frac{1}{2}$ and -2 DE being the unit

The variations of the figure resulting from changes in the signs of the coefficients present no difficulty

An account of the literature on the subject can be found in Encyklopädie der Mathematischen Wissenschaften

* School Science and Mathematics.

Shoe-sole Dressing – Mix over a slow fire 6 000 to 10 000 parts of linseed oil 30 parts spermaceti 15 parts of ceresine 30 parts of resin and 30 parts of turpentine apply the mixture warm to the soles of the shoes and the seams rub off with a rag and dry at the stove

How Exporters Should Pack

Suggestions from United States Consuls and Foreign Business Men

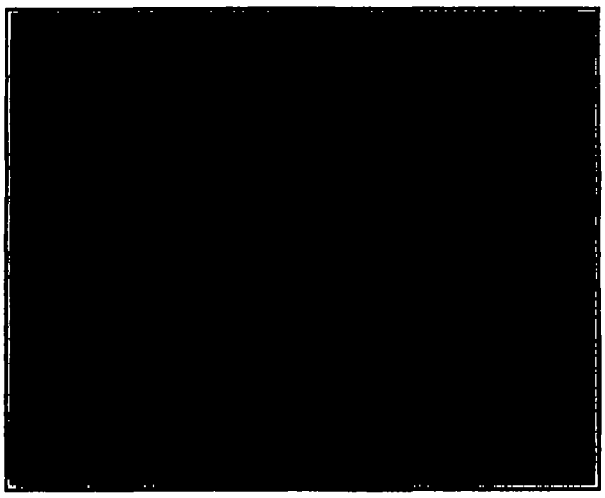
The Bureau of Manufacturers of the Department of Commerce and Labor has in course of preparation and almost ready for the press a monograph on Packing for Export which from the viewpoint of the exporter whether he be shipper of manufactured articles or of natural products is one of the most important publi

What is good packing for shipments to one country may be bad packing for another '

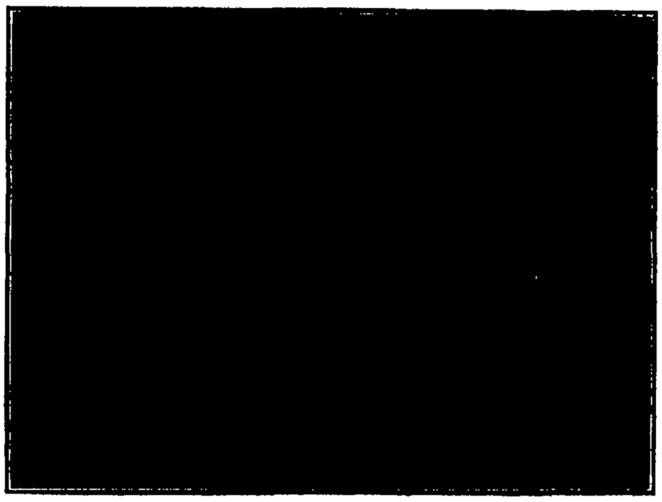
The volume therefore comprises letters from consular officers including criticisms and advice in the effort to help the American exporter

The matter in the following and the accompany

The government bulletin treats at length of the various methods of transportation, rail water rail and water pack animals and man carriers and the style of packing demanded in each instance It also considers the climatic conditions port conditions, danger of pilfering consular regulations marking of shipments



WELL-PACKED SHIPMENT OF PAPER



AMERICAN COTTON PROPERLY PACKED FOR EXPORT

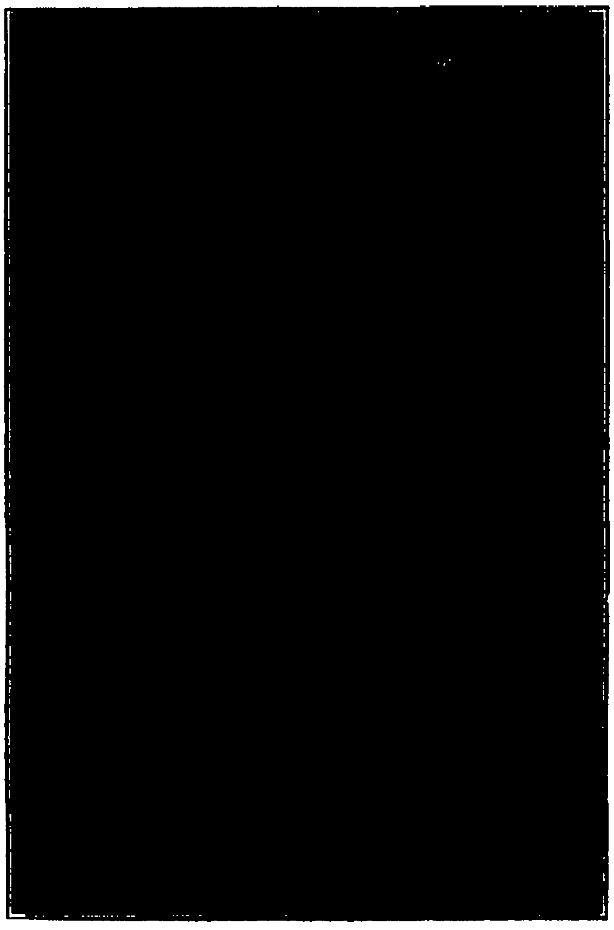
cations over issued for it marks the inauguration of a new propaganda the preachment of the gospel of good packing not from the standpoint of the shipper but from that of the consignee based on the consignee s knowledge of all the conditions at his end of the line which will affect the goods or the materials in which they may be packed The purpose of the monograph will be to tell the shipper just how the consignee wishes the goods packed The consignee from his experience knows what style of packing will

ing illustrations are extracts from the proposed publication

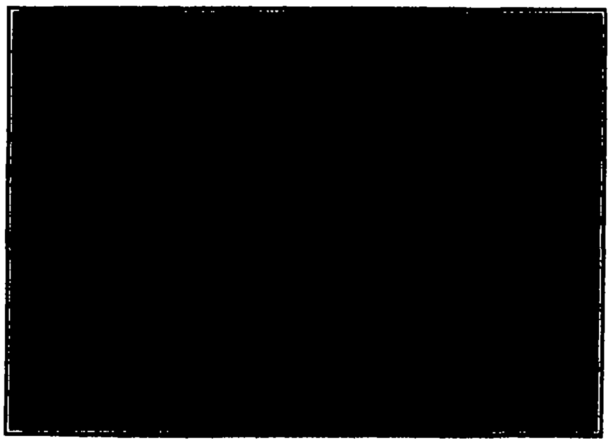
It is said that flagrant cases of defective packing due to the ignorance by Americans of business methods abroad and to the dependence of exporters on their own judgment in such matters have undoubtedly resulted in loss of foreign trade in many instances No doubt the American manufacturer fails to realize that while he may sometimes save a few dollars at this end on a shipment the buyer in foreign markets by rea

and difficulties arising from the use of second hand containers bearing old marks

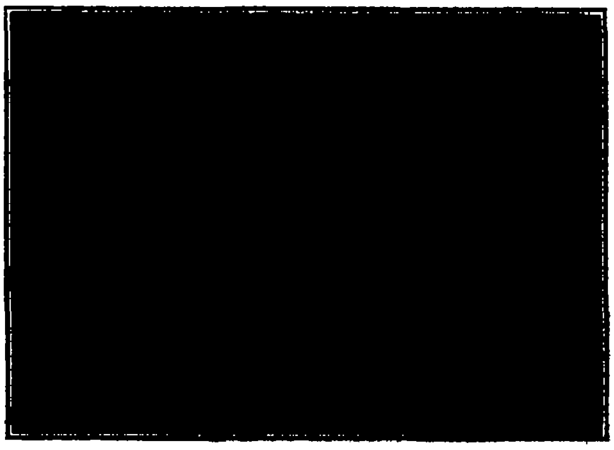
In Ireland certain shipments of American cotton seed meal were received in bags which bore tags showing a guarantee below that called for in the contract Evidently the bags had been previously used for domestic shipments in America and when refilled the tags had not been removed Although the meal held up in analysis to contract quality the tags were a source of annoyance to the Irish importer since many



SHIPPING CASES STRAPPED WITH STEEL BANDS



COTTON CLOTH BALE WITH INADEQUATE WRAPPER



CLOTH CUT BY STEEL BANDS

HOW EXPORTERS SHOULD PACK

stand the handling the goods must receive before reaching his particular point He knows also the packing that will not reach his market in good condition

As Mr A H Baldwin Chief of Bureau of Manufacturers says in his letter submitting the monograph to the secretary

son of lack of facilities to replace broken parts readily and cheaply often has to pay out five or ten times what would have been the original cost in this country or failing to be able to duplicate, there is loss of time and interest on the value of the shipment for several months until parts can be brought from this country "

of his customers complained about them and he was obliged at much expense to have tested samples from each lot sold to show his buyer that the meal ran higher in analysis than the tags indicated. No American cottonseed meal should be exported in bags that have been previously used for such shipments."

The packing of machinery, always an important and

frequently a difficult problem is discussed at length in a very comprehensive article prepared for an English journal by an engineer correspondent and transmitted by Consul Benjamin F Chase of Leeds

The responsibility for poor packing is not always as easily determined as where the manufacturer exports directly for if he ships through an export agent or commission house one party may seek to shift the responsibility to the other Along this line Consul General William H Michael of Calcutta (for many years Chief Clerk of the State Department at Washington) writes

"The goods were packed poorly for foreign trade because the manufacturers packed at the factory for shipment to their export agents in New York or other ports and the export agents instead of repacking simply forwarded the goods in the original cases While the original cases were strong enough and entirely suitable for transportation from the factory to the shipping port, the packing was utterly unsuited to the long and severe strain of transit from point of shipment to India

Frequently much expense can be saved for freight ing by properly proportioning the packages This is well illustrated by Commercial Agent W A Graham Clark of Honduras who tells how a mule can carry 150 or 250 pounds according to the size of the package He says

"It should be noted that if a package weighs as much as 150 pounds a mule can carry only one and as this rests on his backbone he cannot carry much above this weight but he can carry two 125 pound packages strapped one on each side

The information from consuls includes reports from two consuls in Canada three consuls in Mexico one consul each in Central America Costa Rica and Guatemala two in Honduras and so on throughout the world

The definite character of the instructions is illustrated in the report by Consul William W Canada of Vera Cruz who says

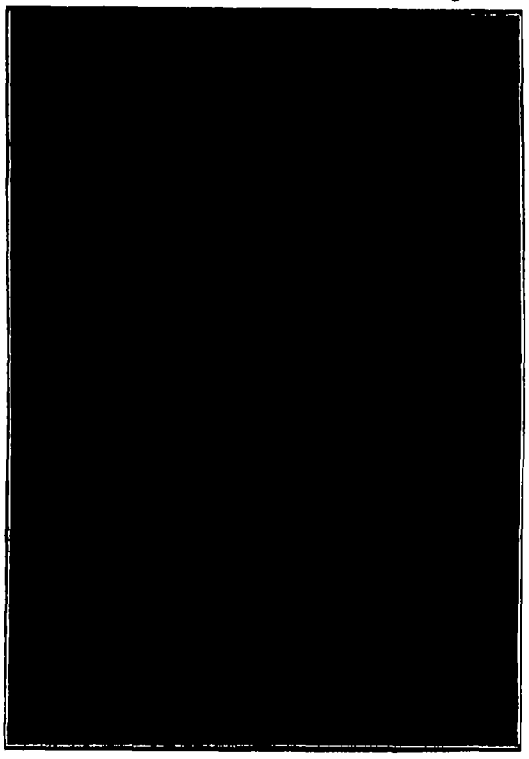
Apparently the campaign inaugurated against faulty packing of merchandise coming from the United States has borne fruit and its good effects are being seen in this port Recently there arrived in Vera Cruz a shipment of 180 kegs of railroad spikes from Pittsburg and of this entire lot only two kegs were in bad condition though their contents were not lost This shipment was put up in first class order as all kegs were hooped with iron and a piece of batten was itted into the tops and bottoms securely nailed and then a piece of strap iron was nailed over these and down the sides of the package

Many ice-cream freezers have been received recently at this port and the methods of packing them should be changed to prevent damage This class of merchandise should be crated in such a manner that there will be no projections outside the crate The articles inside ought to be secure and immovable All detachable parts such as constitute movable mechanism should be secured firmly by wiring The crates in addition to being well and strongly made, should be strapped and wired on the ends"

Consul General Thomas Ewing Dabney of San Salvador says

"Local agents of typewriters have requested that machines be packed in double boxes—one box within

CASE BEARING TOO MANY MARKS



WELL-MADE BOX LINED WITH TIN AND CLOTH

the other—with straw between This will avoid their breaking loose in the cases and being smashed by rough handling

Consul Philip E Holland of Puerto Plata Dominican Republic says

Shippers of tallow should perforate the barrels and recork the holes to avoid leakage By doing this heavy duty would be saved the importer as water tight barrels pay a duty of $1 50 to $3 each regardless of the fact that they are mere coverings

Commercial Agent John M Turner of Argentina and Paraguay says

It is preferable to mark packages on four sides as then a mark will always be in sight On delicate ware the word fragile is suggested as being better than any other as it means the same in a number of languages Stencil marking is better than hand marking with a brush Care should be taken that the mark is distinct before shipping as packages rub together in a ship's hold and marks are liable to be erased or rendered indistinct.

Consul General Maxwell Blake of Colombia says

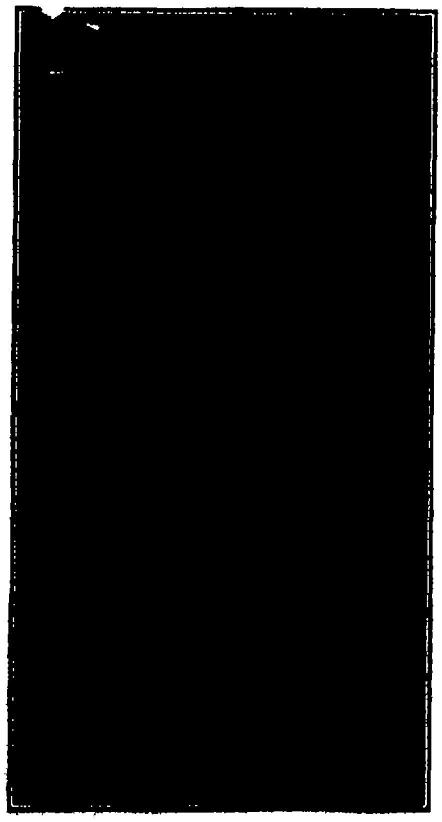
Hacienda proprietors in this country consult each other and manifest a great curiosity with reference to the delivery as to the successful operation of each others new machinery purchased abroad A reputation for unsafe packing is always sufficient to prevent the repetition of such an experience however satisfactory a shipment might otherwise be

As to the This side up with care sign so commonly used in this country Consul General Frank H Mason writing from Paris says

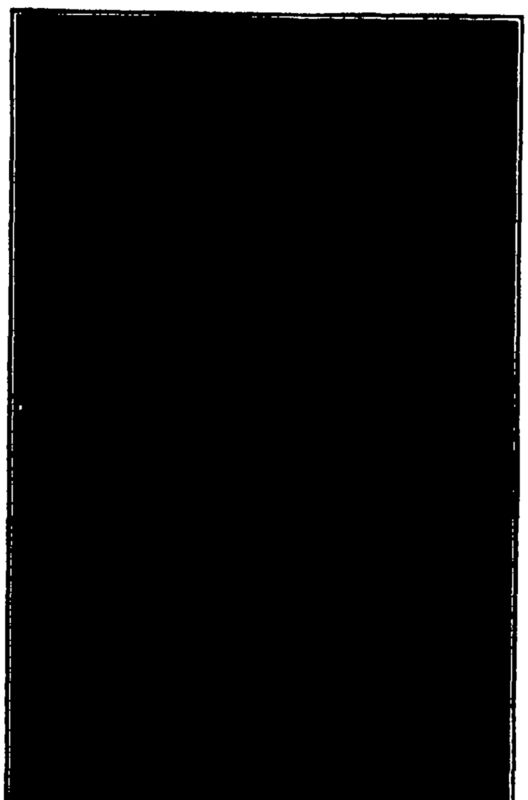
The first general mistake of many American shippers is to pack machinery furniture automobiles etc so that the goods rest on the bottom of the case and they are reasonably safe so long as the case is kept in an upright position They mark the top of the case This side up and take the chance that it will be kept so But in unloading from cars drays and lighters such cases are frequently rolled over and over In the hold of the vessel they are packed so as to secure the greatest economy of space resting on the side or end or even bottom upward At some European ports steam or electric cranes are used which lift the goods out of the hold swing them around and land them more or less gently on the dock At other places the merchandise has to be hoisted on the deck by the vessel's winch and then slid down a long slip slide to the dock striking the bottom with a shock that frequently breaks packages and gives a serious shaking up to the contents

In many of the reports from the consular officers in Europe we find complaint as to the packing of cotton and some point out errors in the packing of apples and other fresh fruits dry fruits lard shoe blacking and other commodities of various kinds

Consul Rufus Fleming of Edinburgh sends an extended report including specific directions for the shipment of a list of over 100 articles comprehending almost all kinds of merchandise and presenting the Scotch idea of the requirements of the trade with great particularity

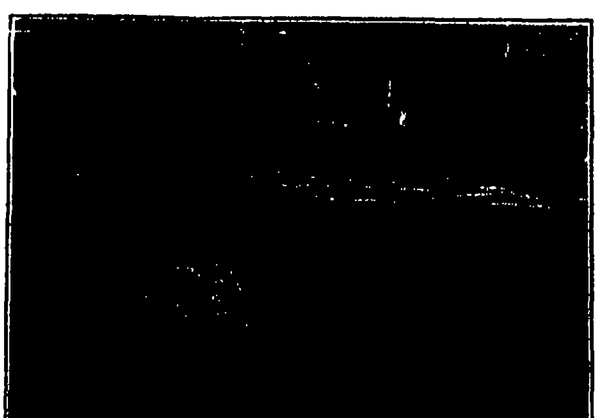


STOVE POORLY PACKED



BOLIVIAN INDIAN FREIGHT CARRIER

BOX AND BALE SHOWING EXCELLENT PACKING



OLD FLOUR BARRELS IN WHICH IRON FITTINGS HAVE BEEN PACKED

HOW EXPORTERS SHOULD PACK

There is hardly a foreign point of the globe from Canada to South Africa the Society Islands, Australia, India or Asiatic Turkey that is not reported in the proposed publication

The illustrations we have given are most interesting and graphically present bad as well as good packing some disastrous results of bad packing and sundry of the freight carriers met with in some of the corners of the world

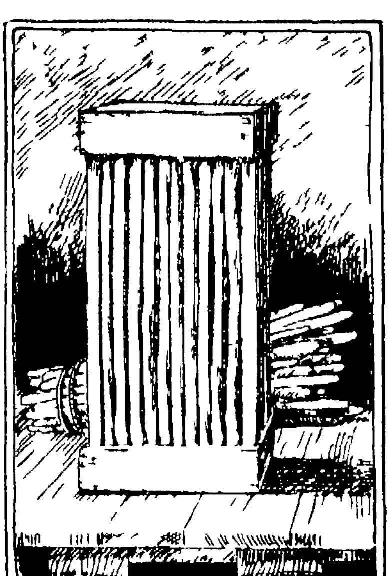
The Bolivian Indian freighter is of special interest Commercial Agent W A Graham Clark of Bolivia says of him

STRAPPED REINFORCED WOODEN PAIL

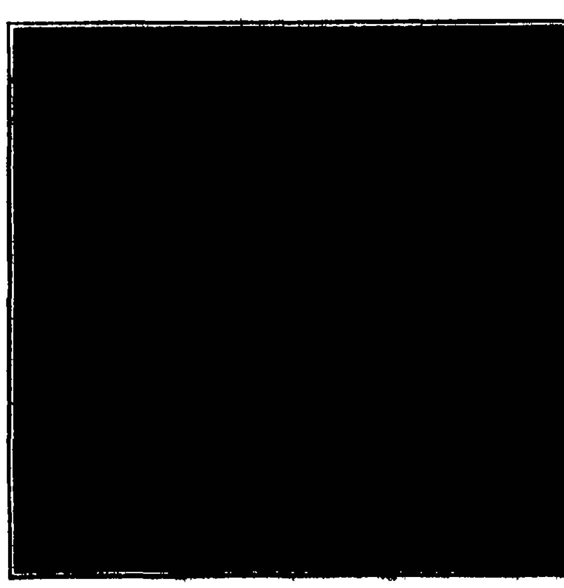
The Indian himself can carry heavy loads He always carries everything on his back never on his head or in his hands It is curious to see him loading He kneels with his back to the load throws around it two or three coils of a rope which he knots across his chest and then bending over on his face he *staggers to his feet* and *moves off* with a load that two men can hardly lift from the ground with their hands

Of the llamas shown in another illustration it is said that while they are slow in their movements and weak carrying only about 100 pounds each they are prized as beasts of burden in the mountainous sections because they forage for themselves and are not affected by the highest altitudes

The bulletin being a Government publication naturally refrains from any official indorsement of patented devices It is evident however that with the interest that must develop in effective packing a field is afforded for the exercise of invention in the product of some standard package adapted to the conditions and supplying the requisite features demanded by many of the points throughout the world to which our products find their way



STOKES IN CRATE



BAR IRON PREPARED FOR TRANSPORTATION BY PACK ANIMALS

HOW EXPORTERS SHOULD PACK

Gyroscopes for Stabilizing Aeroplanes

In a paper by C[illegible]rdville in the *Comptes Rendus* some valuable information is contained on the use of gyroscopes as a mean of balancing aeroplanes The gyroscopes used weighed about five kilogrammes and rotated at 6 000 revolutions per minute The gyrostatic action was used to cause rudders to work automatically Experiments with a fixed apparatus were made in a uniform air current and also in variable winds at the top of the Eiffel Tower It was found that the gyroscope with its pivoted frame tended to acquire an oscillatory movement this was overcome by the use of damping planes immersed in water This difficulty was not experienced when the apparatus was applied to gliders 12 square meters in area, the planes themselves being sufficient to damp the *oscillations* This *gyroscopic* governor successfully compensated for disturbances of balance due to distribution of load and to variable winds and was afterward used with advantage in a motor-driven aeroplane Rotation was first obtained by means of flexible transmission and friction gearing at present the driving power is obtained from a small fan exposed to the draught from the propeller

LLAMAS USED AS PACK ANIMALS

Corrosion of Aluminium

Messrs E Heyn and O Bauer, of the Koenigl Materialpurefungsamt have made some investigations on the decay of aluminium About fifty samples of Al in the form of sheet and various utensils have been tested in water and various solutions of salts with a view to elucidating the cause of corrosion of and the nature of the accompanying efflorescent growth on aluminium cooking utensils The results show that Al may be subject to two kinds of decay (a) uniform attack of the whole surface owing to conversion of Al into hydrated oxide and (b) local attack accompanied by scaling and the formation of a comparatively small amount of aluminium hydroxide results in considerable decay Exposure of sheet Al to the atmosphere alone or air free water alone results in no corrosion the simultaneous presence of water and air being necessary as is the case with iron The hardness of the metal determines to a large extent the nature of the corrosion soft Al is usually attacked uniformly but hard-drawn Al blisters and exfoliates in lines agreeing with the direction of rolling the pressing from a circular sheet resulting in these lines being straight on the bottom and curvilinear on the sides of a pressed cylindrical vessel The harder the Al the more liable it is to local attack and annealing at 450 deg C entirely removes this tendency, the corrosion of annealed sheets being quite uniform. [illegible] water and solutions of several salts such as [illegible] and calcium chloride produce uniform cor[illegible]. The concentration of the salt solution has a gr[illegible] effect on the amount of action, in every case a c[illegible] definite concentration producing the most dele[illegible] effect. The composition of the Al has little or [illegible] effect on the degree of corrosion Greasing the [illegible] with vaseline decreased the tendency to corrode [illegible] diminish the corrosion the authors propose th[illegible] Al should either be less severely cold-worked o[illegible] it should be subsequently annealed at 400 to 45[illegible] C to reduce its hardness, but at the same time point out that this reduces the mechanical strengh of the material.

Building Materials and Noise

A German scientist named Nussbaum has for a long time been studying the question of the suppression of noise in dwelling houses He has experimented both in the laboratory and in private houses One point he has ascertained is that the more solid and tough and strong the building material is the more quickly and loudly it conveys sound and its conductivity can best be tested by strokes with a piece of metal The higher the tone the greater the conductivity

Nussbaum has made many experiments with partition walls He has found that those of tiles and cement transmit sound most and those of solid clay least Between the two comes the wall of ordinary brick, and the more the brick is burned the more noise it transmits A quickly hardening lime mortar is to be preferred to a clay mortar One experiment showed that when a floor was covered with sand and cork mats spread over it hardly any noise penetrated to the room below but that when the cork mats were joined together by any material underneath noises were at once perceptible

To the question How are the sounds of the piano or the violin in the neighboring apartments to be excluded? Nussbaum has returned the suggestion that the ceilings be treated as he successfully treated his telephone cell namely to line them with a layer of zinc or lead

New Zealand's Sulphur Island

One of the most extraordinary islands in the world lies in the Bay of Plenty New Zealand It is called White Island and consists mainly of sulphur mixed with gypsum and a few other minerals Over the island which is about three miles in circumference, and rises between 800 and 900 feet above the sea, there continually floats an immense cloud of vapor attaining an elevation of 10 000 feet

In the center is a boiling lake of acid-charged water covering fifty acres and surrounded with blow holes from which steam and sulphurous fumes are emitted with great force and noise With care a boat can be navigated on the lake. The sulphur from White Island is very pure, but little effort has yet been made to procure it systematically

The Alps Could Run the Railways

Engineers in Zurich report after careful examination that sufficient electric power could be developed from the waterfalls of the Alps to run all the railways of Switzerland. There would be little or no reduction of cost it is said but the time may come when the change from steam to electricity may be desirable, because Switzerland has to import all the coal she uses

From twenty-one waterfalls, some of which are already partially utilized for industrial purposes, [illegible] horse-power could be developed but only 60,000 horse-power would be required to replace the steam power now used on the railroads.

Radiant Energy and Matter—I*

Sir J J Thomson's Royal Institution Lectures

For this course of lectures at the Royal Institution this year Prof Sir J J Thomson of Cambridge has selected the subject of "Radiant Energy and Matter"

In commencing his first lecture Sir J J Thomson said that he thought no apology was needed for his selection of a subject, since as he was informed by Sir James Dewar the last set at the Royal Institution on the subject of radiation were delivered by Prof Tyndall, and formed the basis of his book on "Radiant Heat and Light"

To every inhabitant of the solar system whether of the earth or of Mars the question he continued was one of vital importance The planets did not live on their own resources of energy but were dependent from day to day almost from minute to minute on the supplies received from the sun The solar system in short was equivalent to a system of power distribution on an enormous scale The power house was the sun and the method of distribution was practically one of wireless telegraphy since there was every reason to believe that radiant energy traveled through the ether in a form mechanically equivalent to electric waves The power expended in various ways on the earth was practically wholly received from the sun Thus the energy available in coal was actually solar energy transformed into the energy of chemical separation Water powers again were dependent on the raising of the water to a high level by heat received from the sun The magnitude of the energy thus sent us from that body was far larger than most people realized Actual measurement showed that shining in a clear sky the sun transmitted to the earth energy at the rate of 7 000 horse power per acre

At present this energy was practically all wasted being expended for the most part merely in making the earth a little warmer than it otherwise would be and this effect was most pronounced in regions where any addition to the temperature might well be dispensed with If we knew how to harness this energy we could obtain from it all the power necessary to run the works of the world Various attempts had indeed been made to do this and at the late meeting of the British Association at Sheffield Mr Fessenden had described an installation then in course of construction in one of the hotter States of the Union In this instance it was proposed to use low pressure steam turbines and it was claimed that the cost of the energy thus obtained would be less than half that of the cheapest hitherto available However this might be there was here the speaker continued a great resource for us to fall back upon when coal became scarce and dear and the water powers available had all been taken up

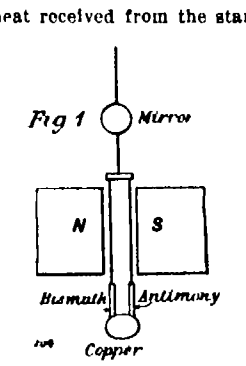
In the present course of lectures he proposed he went on to discuss the manner in which radiant energy was propagated and how the intensity of radiation depended upon the temperature of the body from which it came On this afternoon he would he said confine his discourse to questions concerning the total amount of energy coming out of a radiating body at various temperatures and would reserve for the next lecture questions as to the distribution of the energy in the spectrum according to the color of the light For the study of radiant energy it was necessary to have other means of measurement than the eye Bodies gave out radiant energy at all temperatures above the absolute zero but this energy did not affect the eye unless the temperature of the emitting body was 500 deg F to 600 deg F at least Even then by far the larger proportion of the total energy existed in a form which did not affect the eye and would not be perceived were no other means of detection available Even in the case of the sun three fifths of the energy we received from this body produced no impression on the eye Were however the temperature of the sun doubled only about one fifth of the total energy would escape perception as light while if the sun were still hotter practically the whole of the energy would be received in a visible form With the temperatures actually at our disposal we had means of investigation which would serve where optical methods were not available and these almost all depended upon the conversion of radiant energy into heat

The term "radiant heat" was sometimes used but was rather a misnomer since the energy in question did not become heat, as we now understood the term till it fell upon, and was absorbed by some body It would be better indeed, to call this "radiant heat" electricity as there was every reason to believe that radiation was essentially an electrical phenomenon

* The report here given of Sir J J Thomson's lecture is taken from Engineering.

In measuring the amount of radiant energy the radiation was absorbed and transformed into heat

A very delicate instrument for measuring heat radiation was the bolometer which consisted simply of a strip of platinum on which the radiation was allowed to fall heating the strip and changing its resistance Our means of measuring electrical resistance were the speaker said so delicate that temperature changes almost inconceivably small could thus be detected With this instrument Langley had made his discoveries on the amount of heat the earth received from the sun The bolometer was followed by the radio micrometer of Prof Boys This consisted of a small thermopile (see Fig 1) formed out of a rod of bismuth and another of antimony suspended from a quartz fiber as indicated On heating the junction a current traversed the wires which completed the circuit This circuit lay between the poles of a magnet and the wires tended when the current passed to set themselves square with the lines of magnetic force With this instrument it was possible to measure the radiation received from a candle a mile away Even this instrument was the speaker added surpassed in delicacy by the radiometer of Prof Nicols which was an adaptation of the well known radiometer of Crookes With this instrument Prof Nicols had been able to measure the heat received from the stars



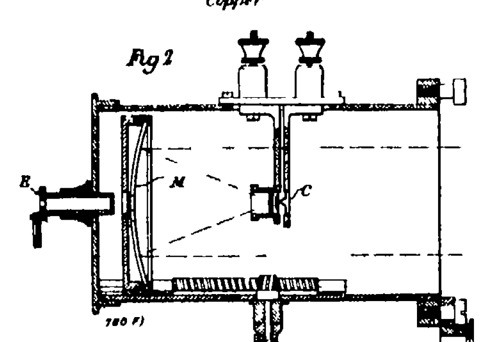


Fig 1 Prof Boys Radiometer consisting of a small circuit suspended between the poles (N S) of a magnet and comprising a thermocouple Fig 2 The Féry Pyrometer The rays of light and heat radiation enter the instrument along the dotted lines from the right strike the mirror *M* and are reflected to the focus at *C* where they fall upon a thermopile This is connected to a galvanometer the deflection of which indicates the temperature of the thermopile and hence of the source The eye piece *E* is used for sighting the instrument on the source whose temperature is to be measured

For his experiment this afternoon the lecturer proceeded he would use a Féry pyrometer of the construction shown in section in Fig 2 The radiant energy entered at the right and falling on the concave mirror *M* was reflected on to a little thermopile at *C* This was connected up to some form of current measurer In the industrial use of the instrument this was an ammeter graduated to give temperature readings direct Though primarily intended for measuring furnace temperatures the instrument could also be applied to measure the amount of radiation from much colder bodies but then more delicate means of detecting the current generated were required and he would himself therefore make use of a galvanometer suspended from the roof of the building so as to be less liable to vibration

Before making use of this instrument however he would he proceeded show another method of detecting radiation which did not affect the eye This was due to the elder Becquerel who found that if a phosphorescent body such as zinc blende were rendered phosphorescent by exposure to a bright light and then afterwards exposed to radiant energy of a different kind the part exposed to certain descriptions of black light became almost as black as if painted with a brush This observation could be used as the basis of a method of detecting radiant energy not perceptible by the eye The range of radiation which produced the effect was not however very great lying just a little on the infra-red side of the spectrum

Exposing a plate covered with zinc blende and rendered phosphorescent to the spectrum of an arc lamp the lecturer showed that the portion which caught the infra red rays became quite black Similarly, if a sheet of ebonite were placed between the phosphorescent sheet and the light of an arc lamp the rays which got through this opaque sheet again extinguished the phosphorescence and a similar effect was shown to be produced by the radiation which traversed a solution of iodine in bisulphide of carbon Methods of detection based on these phenomena were Sir Joseph continued available with radiation of a certain kind but for most purposes it was necessary to fall back on the methods already mentioned in which the radiation was absorbed and transformed into heat

A vital question he proceeded was the relation between the temperature of a body and the total amount of radiation given out by it Newton thought that the amount of energy radiated from a body was proportional to the difference between the temperature of the body and that of its surroundings This was true for small temperature differences whatever the true law of radiation but it did not give us much help when dealing with widely different temperatures Applying Newton's law Watson had estimated the temperature of the sun as 7 000 000 deg C which was about 1 000 times its proper value The true law connecting radiation with temperature had been known for several years and its discovery originated in some experiments by Tyndall who measured the radiation from a piece of platinum at different temperatures Thus at 1 200 deg C he found that the amount of radiation was 11 7 times as much as at 525 deg C Taking these figures Stefan tried to find a relation between the two absolute temperatures and the amount of the radiation emitted In the first case the absolute temperature was 1 473 deg and in the second 798 deg F Then Stefan found that the ratio $\left(\frac{1473}{798}\right)^4$ was about equal to 11 7 and this suggested to him that the energy of radiation from a body was proportional to the fourth power of the absolute temperature Thus if the absolute temperature were doubled the energy radiated out would be 16 times as great

This was Prof Thomson continued perhaps the most important law as to radiant energy yet discovered and it was known as the fourth power law Originally discovered by Stefan as stated it had been abundantly verified since and it had further been found to have a strong basis in thermodynamics A discussion of this he would however defer until he had in a subsequent lecture shown the existence of a pressure due to radiation as this pressure was the basis on which Boltzmann and others had shown from thermodynamic considerations that the radiation must vary with the fourth power of the temperature

The fourth power law the lecturer continued had been extended and physicists were able to say not merely the rate at which radiation varied with the temperature but also the actual amount of energy emitted by a body at any temperature

Thus according to Kaulbars the radiation emitted per second from 1 square centimeter of the surface of a blackened body was equal to $\sigma\theta^4$ where $\sigma = 5.72 \times 10^{-5}$ ergs and θ denoted the absolute temperature

If a body had a temperature of 1 000 degrees therefore it emitted from each square centimeter of its surface 5.5×10^7 ergs per second or in other words gave out energy at the rate of about 1/200 horse power per square centimeter This radiation moreover came out from a very thin layer Assuming this layer to be even as much as 1/100 millimeter thick then a cubic centimeter of the surface of a body at 1000 degrees transformed energy at the rate of 7 horse power This which was really an underestimate well illustrated the speaker said the compactness of the mechanism by which heat was transformed into radiation Since the amount of energy coming out was so large it was easy to understand the rapid extinction of light from small particles such as sparks

One very interesting application of the equation just given was he said to the determination of the temperature of the sun Though somewhat difficult owing to the effects of atmospheric absorption it was possible to measure the intensity of the radiation received from each square centimeter of the sun's surface and from this to deduce the temperature of the latter The most accurate results appeared to make this about 6 000 degrees absolute which was much lower than was at one time thought At 6 000 degrees absolute the rate at which energy was radiated per square foot of surface was formidable, being about 15,000 horse-power How

then did the sun keep on radiating at this rate without getting appreciably colder? Nowadays we always tried to see if radioactivity would not suffice in such cases In the case of the sun the energy could not be supplied by radium as the life of the latter was too short being quite insignificant compared with geological time In this respect uranium being very much longer lived fitted in all right, but it remained to be seen whether the possession of a good supply of uranium would be enough to supply energy at the rate required Unfortunately on making the calculation it turned out that even if the sun consisted wholly of uranium the rate of energy supply would still be insufficient. The sun's surface radiated energy at the rate of 1.2×10^{11} ergs per second, while uranium liberated energy at the rate of 1 erg per second per gramme Hence the number of grammes of uranium below each square centimeter of the sun's surface would need to be 1.2×10^{11} and the whole mass below 1 square centimeter of the sun's surface was actually nothing like as great. Hence it was necessary to give up radioactivity as a sufficient source of the sun's energy and in consequence almost the only hypothesis at present tenable was that at first put forward by Helmholtz An influx of meteors into the sun had been suggested by some as the source of the solar energy The objection to this was that in that case the earth must act, to a certain extent, as an umbrella, and calculation showed that, if it received a corresponding proportion of the assumed meteoric shower, the number received would be enough to make the earth red hot. Helmholtz had in consequence suggested that the energy was supplied by the sun's attraction on itself This hypothesis implied that the sun was shrinking at the rate of about 200 feet per year and with existing means of measurement there was at present nothing to be said against this conclusion

(To be continued.)

Carbureters and Vaporizers*

How They Should be Designed

By T A Borthwick

An analysis at all approaching completeness of even one tenth of the carbureters for vaporizing gasoline or kerosene that are now being manufactured either as belonging to a definite machine or being placed on the market as an accessory would be a work extending to several volumes The scope of this field may be gaged by a glance at the patents review of the technical journals where two or three specifications of newly patented designs may be found almost every week It is therefore not intended here to deal with them fully as regards their mechanical arrangement but to consider the conditions most favorable for the economical and satisfactory production of a combustible fuel and to trace its path from the entry into the float chamber until it reaches the combustion chamber

It may be taken primarily that the use of a jet of which the effective level is regulated by a float chamber as originated by Maybach is almost universally adopted in all cases in which gasoline is the fuel This type is also used to a very large extent in engines using refined and semi refined kerosene It is with devices of this kind that this article will deal

It is a matter for surprise that the use of such a delicate and uncertain piece of apparatus has not been avoided In fact the float chamber has received very little attention beyond the arrangement of the balance weights or in attempts to dispense with them altogether

The arrangements shown in Figs 1 2 and 3 are those most commonly adopted in current practice Fig 1 is arranged so as to admit the lightest possible working parts and thus minimize the troubles due to inertia when traveling over uneven roads It has the further merit that any surplus of gasoline escaping on account of vibrations of the needle valve causes the float to press more heavily on the balance weight and thus to close the valve more tightly on its seat

The arrangement shown in Fig 2 requires the needle and its fittings to be somewhat heavier than in Fig 1 since the pressure due to the weight alone acts to keep the valve on its seat The design shown in Fig 3 has the merit of simplicity and has also the same advantages as Fig 1 but it is open to the objection that the gasoline pipe has to be uncoupled every time the float chamber is opened an occurrence which happens not infrequently especially with kerosene

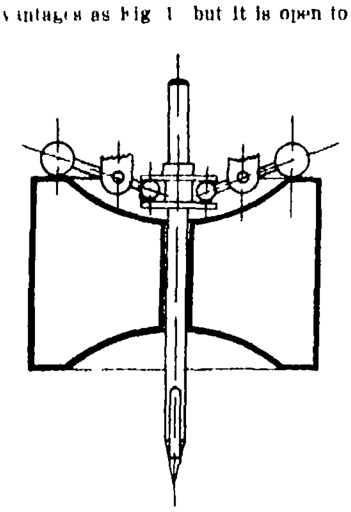


Fig 1 DIRECT NEEDLE VALVE

Among improvements relating to the float chamber that known as the Gillet Schwarz device is one of the more important This consists of a through connection between the mixture pipe and the space above the fuel pipe in the float chamber by means of a branch pipe to which is attached a cock making the effective area of the through connection adjustable The resultant effect of this device is to tend to produce a constant ratio between the pressure in the float chamber and that over the jet or in other words to produce a constant effective height for the jet and therefore on the wider opening of the throttle to give a weaker mixture It may perhaps be satisfactory to

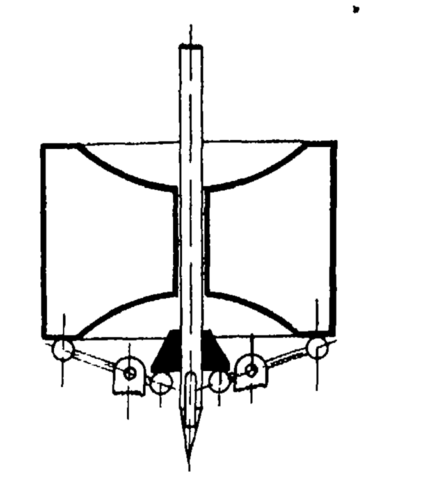


Fig 2 INVERTED NEEDLE VALVE

explain the desirability of this weakening of the mixture with the opening of the throttle by reminding the reader that with a partially closed throttle the cylinder is only partially filled consequently the compression pressure is lowered and a richer mixture is required to enable it to be ignited The best pressure ratio is obtained experimentally by opening or closing the cock in the by pass as may be required Another and perhaps more valuable quality in the Gillet-Schwarz device is that in multi cylinder engines it discriminates between the supplies of mixture to each cylinder e g in four and more particularly in six cylinder engines it will frequently be found that the mixtures are required of different strengths for the different cylinders as shown by the fact that some of the cylinders will fire weakly or miss altogether while the remainder will fire well This is partially due to variations in the volumes of the combustion chambers but more largely because of leaking past valves and valve covers and perhaps it is also due to a still larger extent to the timing of the valves not being uniform throughout the cylinders This device assists in partially neutralizing the last two faults since the effective height of the jet being approximately constant the cylinder with the stronger suction will draw the moist air and as it will have nearly a uniformly higher compression the ignition of the charge is assured On the other hand the cylinder with the weaker suction and consequently weaker compression will draw less air thus forming a richer and more readily fired mixture

After mentioning the above device we may add that the same principle has been utilized in a carbureter brought out by Messrs Cravens Ltd of Sheffield

Little else need be said with regard to the float chamber except perhaps a note about the position of the hole between the float chamber and the jet One frequently finds that this is situated at the bottom of the chamber where it draws any grit or sediment which may find its way inward The hole should be at least a quarter of an inch from the bottom or preferably more since even if a gasoline filter is provided one finds that dirt still finds its way in by some mysterious means It must also be remembered that it is not safe to assume that adequate precautions are taken to exclude all dirt when the gasoline pipe is uncoupled or when the float chamber cover is removed.

A final item to be noted is the needle valve It is frequently found that this is made of mild steel, and, therefore exceedingly liable to become rusted in the presence of gasoline It should, therefore be made of a high percentage nickel steel, or of silver steel.

Before dealing with the details of the mixed chamber it is desirable to consider the general disposition of the mechanism of the carbureter For purposes of comparison we may divide all carbureters into two classes—vertical and horizontal Referring to the former class it may be noted that the vertical carbureter usually gives a more direct flow for the gases, has fewer bends is more economical in fuel consumption than the horizontal type and is furthermore, not so liable to become choked As an offset to these good qualities the horizontal carbureter is undoubtedly easier to be started since the incoming air rushes directly across the top of the jet instead of flowing along it

We will now consider some of the very simplest forms of carburetors being those without any kind of automatic controlling device for the auxiliary air inlet and hence without any means of discrimination between requirements of a full throttle at low speeds and the same at high speeds This class of carburetors is by no means the largest but, speaking generally they give singularly satisfactory results very nearly equaling those attained by carbureters provided with the most accurate adjustments Under these circumstances one is almost inclined to wonder whether for practical purposes the extra complications and delicate parts of the more refined devices are warranted

Taking a few typical examples of this class we will first examine the White & Poppe carbureter which is well to the fore in its line The general arrangement is shown diagrammatically in Fig 4 from which it will be seen that a vertical rotary throttle is placed in the path of the inlet gases and that the throttle casting forms a shroud over the jet a gasoline tight joint being formed between it and the conical top of the jet and the shroud being kept on its seating by means of the spring *A* The hole in the jet and the shroud is disposed eccentrically in such a way that the jet the air inlet and the mixture outlet are all cut off simultaneously and in a definite, predetermined proportion A simpler and more satisfactory way of effecting this three-fold function could hardly be imagined The only adjustment of any kind is that for the air outlet, by means of the sleeve interposed between the throttle and the casing. This is operated by moving two stops on the chamber cover,

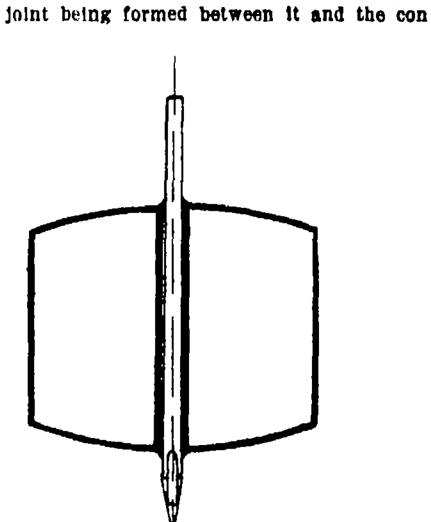


Fig 3—FLOAT AND NEEDLE VALVE

* Reprinted from *Cassier's Magazine*

and compensates for varying atmospheric conditions, and also for different qualities of gasoline.

The remaining portion of the White & Poppe carbureter is a short trunk placed between the mixture outlet and the engine inlet pipe, it serves the purpose of removing any heavy particles of gasoline therefore making the mixture more homogeneous. We believe, however, that this atomising chamber has been omitted in the latest designs of this carbureter.

An approximately similar carbureter but of the vertical type is the Claudel Holson which however has a different kind of jet and one which is both ingenious and interesting. Referring to Fig 5 the hair line circle represents the throttle and it will be seen that the jet outlet and also the holes in the sleeve surrounding the jet, are inclosed by the throttle while the holes at the bottom of the sleeve are outside the jet. The function of the sleeve may be explained as follows. Assuming a partially closed throttle the holes at the top of the sleeve will be in a partial vacuum caused by the suction of the engine while the holes at the bottom will be approximately at atmospheric pressure. A current of air will therefore pass upward inside the sleeve and draw upon the jet. If, however the throttle were fully open the top holes would be nearer atmospheric pressure and the pressure difference between the top and bottom holes would be less and therefore there would be less suction on the jet from this source.

By these means the requirements of proportionately richer mixtures for the lighter throttles are effectively and simply met. It may be added that the Claudel Holson is an exceedingly well constructed and designed carbureter affording a specially smooth and straight forward flow for the gases.

Another example of this type of carbureter is one which has been fitted on the Belsize cars. It is of the vertical type and is so arranged that a throat of con

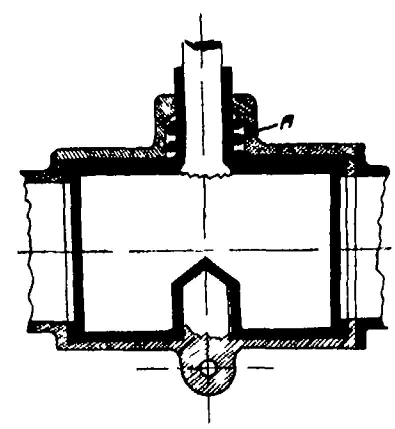


FIG 4—WHITE AND POPPE CARBURETER

stant size is maintained but that simultaneously with the rotation of the throttle a screw of quick pitch is also rotated and by its means a sleeve is lifted in a circular chamber coned inward and therefore the effective air inlet is increased and the mixture is atomized higher up in the carbureter prior to reaching the throttle. Further examples of this type of carbureter are the Trier & Martin triple jet the Craven already mentioned under the heading of float chamber and the H P carbureter. This last has a simple means by which if desired air only may be drawn into the engine after the complete closing of the throttle.

As regards the jet it may be mentioned that it should be kept as large as possible in order to lessen the disturbing and fluctuating influence of friction. Since however for slow running with no load the quantity required is almost infinitesimal the idea of providing a separate jet or a variable jet to serve this purpose may be worthy of consideration. The former method, of a separate jet is probably the better one of the two unless some method is adopted similar to that used in the White & Poppe carbureter in which the jet is cut off eccentrically. The earlier method adopted by a number of makers of lowering a taper needle into the jet, is not nearly so good since capillary attraction and jet friction combine to make the supply very variable. It should be emphasized however that the secondary jet is to be used solely for the purpose stated, and should be neutralized or preferably cut off positively for working positions under load.

It may be recalled that a year or two ago several triple and quadruple jet carbureters were brought out but these have for the most part since been abandoned. These would obviously have an abnormal amount of jet friction and therefore be sluggish in action. For reasons already stated, they would not give uniform results, as the friction even under uniform atmospheric conditions does not remain a constant quantity.

A form of jet, as fitted to the Itala and other vertical carbureters, may here be mentioned, it is shown in Fig 6. It will be seen that the gasoline is compelled to leave the jet head radially the object is to integrate it with the incoming air, but it is somewhat questionable whether it penetrates any further into the stream of air than that which immediately surrounds the jet.

In considering the subject of the throat of a carbureter several features should be taken into account.

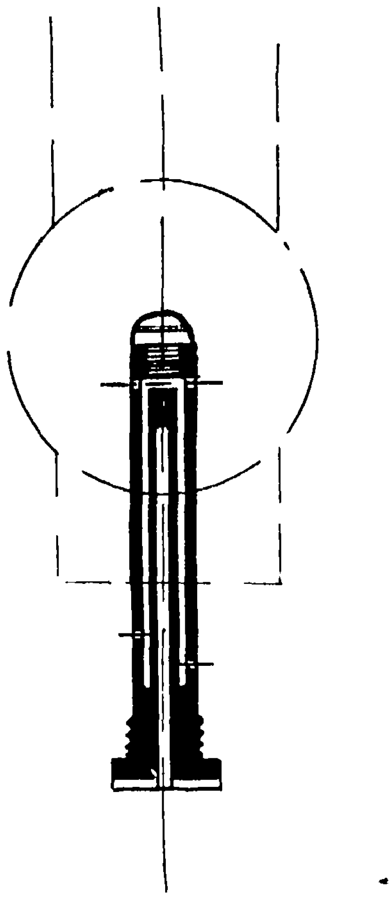


FIG 5—CLAUDEL-HOLSON CARBURETER

So far as the surfaces are concerned one has only to compare the action of a rough and a machined throat of similar dimensions to appreciate the influence of the nature of surface upon performance. We may also add that we have found engines to run appreciably better with inlet pipes made of solid drawn copper tubing than when made of castings of similar shape and size.

When a carbureter for gasoline is fitted with a throat of constant diameter it will be found that the most satisfactory size is that which gives the air a velocity of about 100 feet per second for a horizontal throat or 120 feet per second for a vertical throat.

Taking as an example an engine of four inches bore and five inches stroke and capable of being throttled down to 160 revolutions per minute the carbureters assuming the cylinders to be properly filled should have a throat area of 0.358 square inch corresponding to about 11/16 inch diameter when of the horizontal pattern and 0.298 square inch or 5/8 inch diameter if of the vertical pattern.

It is however more than probable that when the engine is idly rotating at that speed the throttle aperture does not allow the cylinders to become more than one third full. To cover this condition and also to get the best mean for general working it is advisable to fit a cut off for the throat although this is not generally provided. On the White & Poppe carbureter the throat is mechanically enlarged and it is found that an engine of the size given above will run very light when in good condition at 160 revolutions per minute with an effective throat area equivalent to a diameter of 3/16 of an inch.

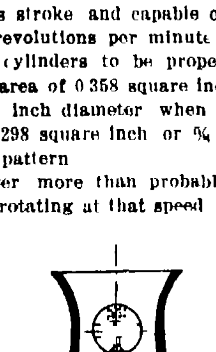


FIG 6—ITALA CARBURETER

This throat reduction is done in a very ingenious manner in the Trier & Martin carbureter. In the earlier patterns a vertical shutter was hung across the throat and cut off all but a small portion until the suction of the engine became powerful enough to lift it out of the way. More recently the same makers have used a device shown in Fig 7 which is self explanatory the suction of the engine pulls the spring and allows additional air to pass between the coils. A similar spring device has been used to operate an auxiliary air inlet.

In many carbureters of the horizontal pattern there is no reason why a much greater application of the *vena contracta* should not be made and the throat enlarged accordingly. Taking the case which we have already considered that is a throat 11/16 inch diameter and also take the *vena contracta* constant as 0.6 we might enlarge the throat to 0.37 ÷ 0.6 square inch or 0.601 square inch or 7/8 inch diameter and place the jet where the contradiction occurs. This plan could of course be quite logically adopted with vertical carbureters but the application of it would present some difficulties in the arrangement of the parts.

Regarding the use of other spirits than gasoline it may be mentioned that benzol methylated spirits and also benzine may all be used without alteration to the gasoline carbureter other than the change in the size of the jet. Benzine is somewhat slow and heavy in its working but methylated spirit gives an exceedingly lively engine and also very good results from the point of view of power output but it also makes an engine which is somewhat too hard in working for general use.

The use of fuels of the kerosene type such as the American White Rose or Royal Daylight the Russian Russolene Scottish Lighthouse Burma Victoria or refined Borneo and the numerous other oils of approximately the same nature also the heavier and more sluggish spirits such as the usual commercial grades of naphtha presents no very great difficulties after the few necessary modifications have been made in the design of the carbureter.

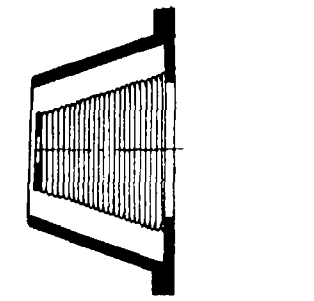


FIG 7—TRIER AND MARTIN NOZZLE

It is necessary primarily to provide a vaporizer which may be heated by the exhaust gases of the engine or by other means such as a blowlamp. This vaporizer should be so designed that as large a surface as possible is presented to the incoming mixture in order to prevent the formation of a core of unvaporized mixture this latter condition being apt to occur if tubes of at all large diameter are used.

The method of drawing in the air is different from that used with the gasoline carbureter. With the carbureter for kerosene the amount of air passing through the throat must be only sufficient to lift the oil out of the jet and carry it onward so that the unvaporized mixture is not sufficiently rich in oxygen to become ignited in the vaporizer.

The additional air required to form the explosive mixture is taken in by means of a separate valve between the vaporizer and the engine inlet valve. There are a few carbureters for kerosene on the market as a specialty the majority being the exclusive designs adapted to and confined to the engines of the makers.

Wireless Railroad Signals

For some time past the Prussian and Bavarian authorities have been experimenting with a system of wireless telegraph signals for railroads which is said to promise good results. An aerial transmitter wire is carried on the telegraph poles at the side of the road with transmitting stations in the signal bell towers and a wire loop antenna is placed on the top of one of the cars of the train. By this means signal to stop go ahead go slow and so on can be transmitted to moving trains over an effective range of 12 kilometers nearly 7½ miles. The average distance between the bell towers on German railroads is only 18 kilometers so that the range of the signals is amply sufficient.

Dressing for Hunting Boots.—Seven hundred parts of yellow vaseline oil 50 parts of olive oil 250 parts of yellow ceresine 1 part anchusine 10 drops oil of mirbane 5 drops of East Indian balm oil.

The Lost Arts of Chemistry*

The Origin and Reason for Some Widespread Beliefs

By W D Richardson

IN addition to chronicling past and present events merely it pleases the historian from time to time to ascertain as nearly as he can by a comparison of present with past conditions and present knowledge and practise with past knowledge and practise the present condition of mankind of any particular society in comparison with past conditions Thus are compared present systems of government with past systems new religious beliefs with old modern science with ancient science present day arts and manufactures with those of old

Progress never takes a straight course for any considerable length of time Nor does it even follow an undulating course in one general direction But there are advancements and retrogressions repeated endlessly And again progress as recorded by history does not represent necessarily the progress of the whole human race On the contrary it does not represent even a large part of the human race but at most an isolated portion of it and in this isolated portion the progress is recorded not of the whole but of the most advanced individuals only When we say that the present age is one of great business scientific and manufacturing or artistic achievements in comparison with the fourteenth century for example we mean that a few individuals very few in fact compared with the total number have contrived to bring about great results in those fields of human activity But we must remember at the same time that the majority of individuals may not have been directly concerned in the advance or may not have contributed directly to it at all Indeed it seems as though the lowest members of the human race to day are no farther advanced mentally than were their progenitors in recent geologic times Even with rapid progress of the most favored or most enterprising individuals there may be little progress or none in the case of the average of mankind It is not unlikely that at the present day the intellectual gap between the mentally highest and lowest of mankind is greater than at any previous time

In spite of the high intellectual and practical stand ard reached by the leading men of to day from another point of view (called by some the pessimistic) the outlook to-day is far from satisfactory in politics religion manufacture or science Whether we consider our all but failing efforts at democracy in the United States or the vacillating and undirected religious tendencies of the people (as shown by Mormonism Seventh Day Adventism Dowieism Christian Science the old theologies or the strange oriental doctrines and ideals of the majority of our people which fortunately are scarcely put into practise) or if we consider the slow conservatism and plodding course of manufacture and business including our great untouched problem of the economic distribution of goods we can not fail to be impressed with the length of the journey which we must sooner or later take on the road of development

But we may turn from the rather unsatisfactory consideration of politics religion and business to the consideration of modern science with a rare degree of satisfaction and enthusiasm There at least progress is visible tangible or even obtrusive There at least the forward movement does not take the slow conservative timid pace of business nor follow the meandering uncertain sentimental path of religion or the crude meaningless way of politics In that field at least the way is certain the methods positive the results satisfying the application secure and the progress lively Considered by itself science and the scientific method are the most satisfactory and satisfying things in the possession of the human mind The unfortunate thing—it can not be classed as a criticism—about science is that it has left the multitude untouched With the results of science and the scientific method on every hand forming so large a part of our splendid materialistic civilization nevertheless the great the overwhelming majority of people are ignorant of the methods the aims and the results of scientific inquiry in daily use and of daily necessity Of even greater import the scientific method of thought is not a part of their mental equipment.

Science and the scientific method have their critics no less than other excellent things Science is unmoral cold heartless pessimistic hopeless often cruel in method say they The scientific inquirer can well afford to let most of such accusations as these go unchallenged But there is one statement which has been sown broadcast which springs up in a thousand unexpected places and which it is worth while to devote some attention to in order to refute it. It is the statement that ancient peoples have been possessed of knowledge and of arts unknown to modern times and indeed people would have us believe that this knowledge and these arts are recoverable by us if at all only with extreme difficulty The lost arts is the cry In so far as these so-called lost arts concern applied chemistry let us examine into them and ascertain if possible whether or not there is truth in the assertions alluded to

In the first place we may well inquire into the origin of the widespread belief that the knowledge of various mechanical and chemical arts has been lost to mankind Probably first among the causes is that universal veneration of antiquity which makes gods and saints out of heroes and martyrs of the past leads to ancestor worship and in general exaggerates the virtues the crafts and the deeds of valor of olden times Secondly the delight of many persons in mystery their tendency toward belief in the mysterious occult and miraculous against their better judgment and the facts in the case have great influence in originating and perpetuating the belief in lost arts Thirdly among the more general causes we may place vague statements or sentences which we cannot accurately translate in ancient manuscripts Fourthly the natural reaction against an egotistical age Fifthly the use by ancient peoples for certain purposes of materials which we would not use to-day on account of their unsuitability This leads to the conclusion that the ancients knew of different and better methods of preparing the material Sixth it has pleased certain writers and lecturers to insist strongly upon the point that there have been at various times in existence arts no longer known and used One finds brief statements in various books of such import as they knew how to harden copper Their mortar outlasted the stone it cemented The degree of perfection they reached in enameling has never since been attained etc In America the man who has had probably more effect than others in this respect was Wendell Phillips His lecture entitled The Lost Arts was first delivered in the American Lyceum course in the winter of 1838 During succeeding years the lecture was repeated about 2 000 times and was heard by all sorts of audiences throughout the country and at the time and subsequently made a great impression Many persons now living still remember the famous lecture It is difficult to read this lecture to day and believe that it was seriously intended in certain places by Wendell Phillips yet I am assured by several individuals who heard it that, although illumined by humor in places it was as a whole seriously intended and received In various lectures Phillips committed many sins against accuracy and truth but in none more than in the Lost Arts He misquoted Pliny in regard to his statements about the origin of glass manufacture—a tale familiar to you all and hardly rising to the dignity of a first class fable And of all authors Pliny can least afford to be misquoted being already overburdened with inaccuracy and unreliability Let me present a few brief quotations from this remarkable lecture

The chemistry of the most ancient period had reached a point which we have never even approached and which we in vain struggle to reach to-day In deed the whole management of the effect of light on glass is still a matter of profound study

The second story of half a dozen—certainly five—related to the age of Tiberius the time of Saint Paul and tells of a Roman who had been banished and who returned to Rome bringing a wonderful cup This cup he dashed upon the marble pavement and it was crushed, not broken by the fall It was dented some, and with a hammer he easily brought it into shape again It was brilliant transparent but not brittle I had a wineglass when I made this talk in New Haven and among the audience was the owner Prof Silliman He was kind enough to come to the platform when I had ended and say that he was familiar with most of my facts but speaking of malleable glass he had this to say—that it was nearly a natural impossibility and that no amount of evidence which could be brought would make him credit it. Well the Romans got their chemistry from the Arabians, they brought it into Spain eight centuries ago, and in their books of that age they claim that they got from the Arabians malleable glass There is a kind of glass spoken of there that, if supported by one end, by its own weight in twenty hours would dwindle down to a fine line and that you could curve it around your wrist.

Cicero said that he had seen the entire Iliad, which is a poem as large as the New Testament, written on a skin so that it could be rolled up in the compass of a nut-shell Now this is imperceptible to the ordinary eye You have seen the Declaration of Independence in the compass of a quarter of a dollar written with glasses I have to-day a paper at home as long as half my hand, on which was photographed the whole contents of a London newspaper It was put under a doves wing and sent into Paris, where they enlarged it and read the news This copy of the Iliad must have been made by some such process

Pliny says that Nero the tyrant had a ring with a gem in it which he looked through and watched the sword play of the gladiators—men who killed each other to amuse the people—more clearly than with the naked eye So Nero had an opera-glass

So Mauritius the Sicilian stood on the promontory of his island and could sweep over the entire sea to the coast of Africa with his nauscopite which is a word derived from two Greek words meaning 'to see a ship Evidently Mauritius who was a pirate had a marine telescope

The French who went to Egypt with Napoleon said that all the colors were perfect except the greenish white which is the hardest for us They had no difficulty with the Tyrian blue The burned city of Pompeii was a city of stucco All the houses are stucco outside and it is stained with Tyrian blue the royal color of antiquity

But you never can rely on the name of a color after a thousand years So the Tyrian blue is almost a red—about the color of these curtains This is a city all of red It had been buried seventeen hundred years and if you take a shovel now and clear away the ashes this color flames up upon you a great deal richer than anything we can produce

I feel reasonably sure from what I know of the history of science that the main points made in this lecture were not true in Wendell Phillips's time I know they are not true to-day

To recapitulate The causes of a belief in lost arts appear to be the veneration of antiquity, the belief in the mysterious and occult inaccuracies in and in accurate readings of ancient texts reaction against present-day egotism the use of unsuitable materials by ancient peoples and the emphasis laid upon ancient skill by half accurate writers

No one could wish to detract from the great, the skilful and the beautiful works of the ancients All we can desire is a proper and clear understanding of their accomplishments

Long before the way was prepared for an approach to chemistry as a science many were the chemical facts known and used, and many the chemical arts and manufactures which arose and flourished The foundations of many of our greatest chemical industries were securely laid long before the science of chemistry lent its aid The industries of cement and plaster, glass, ceramics pigments oils and fats, varnishes and lacquers, sugar fermentation textiles, paper dyeing leather glue and various metallurgical industries are some of those which were very well developed before the advent of scientific chemistry Indeed the science of chemistry has found and still finds some of its richest materials in these very industries. What can be accomplished by patient manual skill and dexterity is amazing and it must be conceded that the adoption of exact mechanical processes in our times has lessened the necessity for such skill in many directions It is true also that many ancient peoples and many of the less mechanical modern ones have applied manual dexterity to their arts in such a way that we marvel at the results. But it is difficult to find a case where similar application to-day would not yield a similar result. Nothing can be considered lost unless it be the demand for and desire to produce works of a certain kind.

Again it is true that some arts and modes of manufacture reach a stage which we may call practical perfection, relatively soon after the initial discoveries are made which give them their first impetus. After this point is reached the improvements are few or none (and if any occur they come from an outside source, as the application of power to the loom). Examples are abundant, the hoe and other simple farming implements; the safety bicycle; the sewing machine; the aeroplane. It must, of course, be remem-

* An address delivered before the Minneapolis meeting of the American Chemical Society

possible that suitable materials for manufacture have been previously discovered and are at hand or can be quickly adapted In such cases as these the opportunities of later generations to develop and improve are meager, but the limitation is not of the inventors, but of the things themselves

For many years the great pyramid of Egypt was held up to the youth in all lands as an example of what had been accomplished by ancient peoples and which could not be duplicated to-day It was held in fact that the ancient Egyptians were possessed of mechanical knowledge and appliances unknown to us We must all concede that the great pyramid is a remarkable if useless piece of architecture laid out with extreme precision and carried to its completion in a masterly way But it turns out that the Egyptians of the Old Kingdom possessed rather limited knowledge of mechanics, not having even developed the movable pulley The great pyramid was built by man power multiplied many thousand times Finally can it be considered a greater work than a great railway system or battleship?

That arts have been temporarily lost at least for practical purposes is true The history of industry has not yet been written—possibly it is too great a task—and adequate data have not been collected and hence are not available but it seems true from the information available that there has been a remarkable continuity in industrial processes in spite of many adverse circumstances

War is probably the greatest cause of breaks in the continuity of manufacturing processes and the arts of peace and if we are to believe past records the domination of theological systems or religious dogmatism has been and is the most effective influence in restraining the development of scientific methods of inquiry and consequently progress in the arts On the other hand commerce and the migrations of peoples have been effective in spreading industries War destroys commerce but often causes migrations and hence has been an active influence in the spreading of industry as well as in checking it War has also imposed new civilizations on old and thus caused an unnatural intercourse between two civilizations which would naturally result in the extension of knowledge of the industries peculiar to each

Let us examine for a few moments some of the arts claimed to be now lost The knowledge of a process for hardening copper is commonly ascribed to many ancient and prehistoric peoples and is devoutly believed in by many persons Now in the first place if this knowledge was formerly possessed we have no direct evidence of it for the copper implements which have come down to us are no harder than those we might make ourselves to-day A metal may be hardened in two ways By physical treatment or by alloying it with other metals or substances Copper may be hardened to some extent by hammering in the same way that many other metals may be hardened The common alloys bronze and brass are harder than the pure metal It is probable that ancient peoples used the process of hammering to harden copper and it is certain that they made use of the alloys of copper first with tin and later with zinc for many purposes including tools and implements But because copper and copper alloys were used for implements subjected to rough usage this does not justify us in concluding that the makers had knowledge of a method for making the metal hard durable and serviceable The simple and direct explanation is that they had no better material for the purpose at their command just as in the bone and stone periods bone and stone were the best materials of construction available for tools and implements There is no justification for the idea that ancient peoples knew how to harden copper by means unknown to metallurgists of the present day

The ceramic arts are among the oldest known to mankind and the earliest development of them will probably remain unknown to us. They had their beginnings in the bone and stone age and were probably first practised by women not by men The first clay vessels may have been clay-covered baskets dried in the sun—we do not know certainly From those early beginnings to the highest types of the art required the labor of many potters numberless experiments and numberless failures We class ceramics among the chemical industries and properly so and yet the ceramic art originated, developed and flourished in many ages and in many parts of the earth without any thought of or aid from the science of chemistry It has always been and still is to a very large extent an empirical industry The essential difference between the pottery practice of ancient times and the most scientific practice of modern times lies in the reproducibility of bodies and glazes by modern methods. And yet few chemists in the industry have the temerity to predict how a new clay or glaze will come out of the kiln. The potters of long ago, by countless [illegible] of [illegible] materials and countless failures, were able to produce certain effects, and they were able to continue the manufacture of similar wares and produce similar effects so long as they were able to obtain materials from the same sources A change of material would almost certainly mean a change in product. It must not be forgotten that this same limitation affects the ceramic industry to-day to a very large extent The varieties and properties of clays are almost numberless It is true that potters of all times have been able to devise certain simple tests whereby they have been able to recognize differences and similarities in their raw materials but these tests were usually of too crude a character to make refined distinctions Now from the very fact that ancient potters were dependent on certain sources of supply for materials to produce certain wares it was very natural that wares made by a certain people at a certain time were not made by that people at an other period or by different peoples And such a case would probably be classified as a lost art But this cannot properly be called a lost art Rather it is a case of lost materials! Given the materials the wares could be made as at first This in fact has been the work of more recent times—to ascertain by careful analysis the nature of various bodies and glazes and reproduce them Of course the composition is not the whole secret the heat treatment is almost equally important and this is a matter for careful physical testing But as the result of modern research and practical experiment it can scarcely be maintained that any body or glaze exists which has not been and can not be reproduced

Glass manufacture is allied to the ceramic industry and is probably the outgrowth of it In spite of Pliny's fable to account for the origin of glass making it is altogether likely that glazes and enamels were the immediate forerunners of glass Glass manufacture had its origin in Egypt not far from 2500 B C Who shall say that the natural mineral resources of the country (among them limestone sand and alkalis) were not responsible for its origin there? It spread to the countries east and north of Egypt to Greece and Rome to Spain France and more recently to Saxony Bohemia and Austria—finally over the civilized world At the present time the data for a history of glass manufacture are probably as complete and available as that for any other of the chemical industries—and possibly more so The ancient glasses were usually not perfectly transparent but were translucent in some cases nearly opaque Transparent glass and particularly transparent glass in large sheets is a modern production Many of the ancient glasses and those of early modern times possessed great beauty considered from the standpoint of the fine arts although their utility as light transmitters is low In Greece and Rome glass was used for plates and saucers and other table ware for pitchers and ornamental objects as tile in pavements and walls but scarcely at all in windows With the advent of transparent glass the production of the translucent varieties did not expand until finally the art languished in many countries and has but recently been revived for many decorative purposes It should be noted that the art was never really lost but the interest in and demand for translucent tinted and rough surfaced glass was low

The dyeing industry is another which dates from the remotest antiquity and which was developed without the aid of scientific chemistry on an empirical groundwork However ancient colors largely derived from vegetable sources were reproducible The use of mordants was practised by many ancient peoples particularly by the ancient Egyptians who used them not only for fixing colors but for producing different shades from the same dye bath With increasing commerce between nations new sources of dyes became available and the vegetable-dying practice had reached a high degree of perfection when the coal tar dyes were brought forth in the chemical laboratory to the wonderment of mankind and the revolutionizing of the industry It has never been claimed I believe that the art of dyeing with vegetable colors has been lost or not practised But there is a strong tendency at the present time to disparage the aniline colors It is very commonly said and accepted as true that vegetable dyes are superior to coal tar dyes That vegetable dyes are fast and coal tar dyes are not Persia has recently prohibited the exportation of rugs and fabrics dyed with anything but vegetable dyes ostensibly to maintain her reputation in the rug industry Who shall come forward and refute these charges, which are of course all but groundless? There are good and bad dyes both coal-tar and vegetable and the best dyes must be skilfully used to produce good results Let us hope that the coal tar dyes will be increasingly appreciated and that the time will not come when people will lament the lost art of vegetable dying!

But what about the cement and plaster of the ancients which outlasted the ages and even the stones which it held together? In the first place any cement or plaster which was not remarkably durable could not possibly have been preserved to this day The ancients in various countries and at various times have been well acquainted with lime burned clay limestone (hydraulic lime) hydraulic cement various natural cements puzzolan and plaster Would it not be strange if among the materials used some would not be found to yield a cement of unusual strength? And if the setting process continued through the ages and conditions were such that weathering did not seriously attack it the final product yielded would certainly be extremely hard But in any case it is certain that the weaker cements have not come down to us but have been disintegrated long ago The cement which is being made in enormous quantity to day under scientific control will probably outlast any similar material which the world has seen

But we may go a step farther in our inquiry after relegating the lost arts to the same mythological museum which holds the lost Atlantis Not only is it unlikely that there are any lost chemical arts but it is highly probable that ancient peoples were ignorant of many arts attributed to them and which are well known at the present day Such a misunderstanding could probably best be dispelled by a carefully compiled history of arts and manufactures particularly ancient arts and manufactures The production of such a book is a consummation devoutly to be wished

I have an idea that it is not a difficult matter to gain a mental picture of conditions in ancient work shops I believe that the mental attitude of artisans has not changed much during the lapse of hundreds or even thousands of years Go into any small shop at the present day where a specialized art or craft is practised and I fancy that you will find the workers there in all essential respects so far as their craft is concerned like the craftsmen of distant ages You will find there the same lack of organized knowledge the same sort of unnecessarily detail d and elaborated empirical knowledge the same narrow conservatism and adherence to formula and rule of thumb methods If you talk to the men you may learn how they learned their craft of the most skilful members of the craft they have known If you gain their confidence they may tell you of their past experiments (most of them foredoomed to failure) and of future experiments planned when time permits or when they obtain material possessed of certain hypothetical properties And you will be impressed by the way results are sometimes accomplished in spite of the use of the clumsiest mental and physical methods of experiment imaginable A typical craftsman will experiment with all the materials he can lay hands on without the slightest scientific consideration of the case in an effort to produce a certain result These things are interesting and we must hope they will never be altogether lost But our ideal for the present and the future must be a large and adequately organized industry resting firmly on engineering skill and chemical investigation operating with a full understanding of all its processes and with assurances of consistent and logical future development and expansion — Science

The Atmosphere of Cities

THE German scientists are studying the atmospheric conditions of their cities The fact that sunshine lessens as population becomes more dense and especially when the activity of industrial centers expands superficially and increases in intensity has long been noted An increasing tendency to fog has also been observed and both are effects of the imperfect and incomplete combustion of coal

Modern industry pays toll for this in the injury of delicate fabrics the general depreciation in the value of many articles of trade and household use and the increased cost of cleansing Since the battle is waged with growing energy against tuberculosis physicians and students of social science feel that the problem of purer air for the dwellers in cities has become one of the first importance

Statistics have been collected for some time past They demonstrate that little sunshine falls to the lot of the residents of industrial cities even when the sun is obscured by smoke particles In no German city has the loss of sunshine due to fogs equaled that of London where the foggy days during the three months of December January and February increased from 18 to 31 during the last half of the last century

To Wash and Clean Embroideries—Dissolve 30 parts of borax in 1,000 parts of river water at moderate heat In washing embroideries do not rub but press them rinse with cold water to which a handful of salt has been added rinse for a few minutes in sharp wine vinegar and press between two other cloths

Automatically Drawn Curves

Instruments that Represent Varying Conditions

By Albert A Somerville

A PIECE of apparatus frequently called for in scientific work is one that will automatically record varying conditions and draw a curve representing the relation between the variables Some such instruments are used for example in the weather service work One of the variables there is nearly always *time* so an accurate time-keeping piece is part of the apparatus being used to move a sheet of cross-section paper at uniform speed while at right angles to the motion of the paper a lever arm moves in accordance with the change in length of a metal rod which expands or contracts with changes in temperature At the same time by means of a stencil arrangement pressing on the paper the lever draws a time-temperature curve from which may be read the temperature corresponding to any instant of time during the period over which the record extends

A very similar method may be used to record barometric pressures from day to day The instrument employed for this purpose is known as a barograph and may be used also to record altitudes reached by a balloon or aeroplane the barometric pressure decreasing with increase in altitude

In electrical work there is a big field for recording instruments and in a well-equipped station there are kept automatically made records of voltage current and power consumed and for certain times in the day the cost of electrical energy is less to the consumer than at other hours during which there is a big demand made on the power station

In all of these cases named one of the factors is the time variable

Just as interesting are other cases involving dynamical data e g forces and their directions and the motions due to those forces In such cases curves may be drawn representing the direction of motion only without respect to time change

One of the most interesting simple cases is that of circular motion as affected by friction and the curves shown in the accompanying illustration are representative of such a case The problem presented is of a type which is considered in probably every book on general physics now being used in schools or colleges

On the principles underlying circular motion depend the following phenomena The tendency of a spinning top to remain upright, the bursting of a rapidly rotating wheel the performance of a loop-the loop the action of cream separators and centrifugal drying machines the force of a sling-shot the necessity for the elevation of the outer rail on a curve in a railroad the lag and lead of trade winds and lastly an amusement device now being extensively used in popular parks whose action resembles in some features the phenomena presented by the trade winds It consists of a smooth horizontal wheel rotated about a vertical axis at such a speed as to throw off any particle resting upon it The wheel is ordinarily 20 or 30 feet in diameter and the amusement takes the form of allowing youngsters to pile onto it while it is at rest and then rotating it gradually increasing the speed until everyone has slid off into the surrounding gutter

The curves shown in Figs 1 and 2 are from a model of such a device In one of the recently published text books there appears the problem Given a certain value for the friction force at what speed is it necessary for the wheel to turn in order that a body may just slide off? To this may be naturally added the question In what direction would the body slide?

In order to clearly understand the problem it is necessary to review briefly certain principles known as Newton's laws relating to bodies in motion or at rest All we need to know is that if a body is in motion it has a tendency to move in a straight line and if it is kept moving uniformly in a circle there must be a constant force pulling in toward the center of the circle or else the body will fly off at a tangent to the circle as is the case with mud or water flying off a revolving wheel or as exemplified by the direction in which a stone travels when revolved in a circle by means of a string and suddenly released by the snapping of the string

It is also useful for us to know that the amount of this force toward the center necessary to keep a body moving in a circle with a uniform velocity is equal to the algebraic expressions $\frac{MV^2}{R}$, in which M is the mass or amount of material in the body V its linear velocity and R the radius of the circle in which it is moving From this we see that as the speed V increases the force necessary to hold the body in the circle increases, and also the smaller R the radius of this circle the smaller is this force

In the case of the boy sitting on the rotating horizontal wheel the only force that holds him at the center or that keeps him from sliding out is friction between him and the surface of the wheel Now friction is something which depends on the nature of the two surfaces in contact. The force necessary to overcome friction is equal to a certain constant K, characteristic of the surfaces in contact, multiplied by the pressure between those surfaces or in this case by the weight of the body which is equal to its mass M multiplied by the acceleration of gravity g

The friction Mgk is constant. If the speed of the

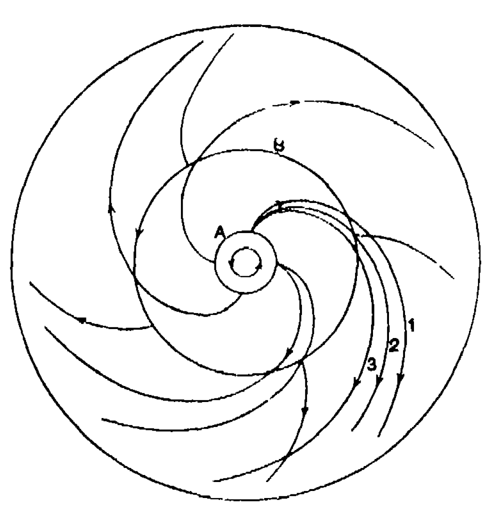


FIG 1

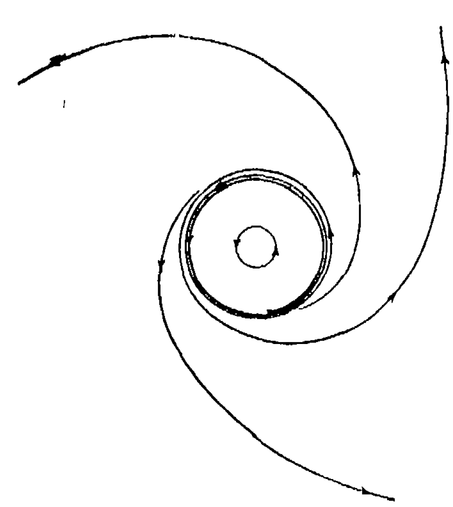


FIG 2

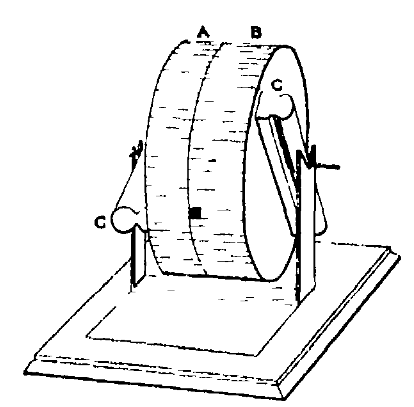
CURVES TRACED BY POINT SLIDING OFF ROTATING HORIZONTAL DISK

wheel is increased the body will begin to slide when $\frac{MV^2}{R}$ becomes equal to or just greater than Mgk i. e., as soon as the equation $\frac{MV^2}{R} = Mgk$ is satisfied

Since M occurs on both sides of the equation we see that the motion is independent of the size or mass of the body and since the force varies as $\frac{V^2}{R}$ and V the linear speed varies directly as R it is evident that a body near the edge will start to slide sooner than one near the center of the wheel To draw the curves a model wheel 2 feet in diameter was used, mounted on a variable speed motor The wheel was covered with a sheet of paper and a block holding a pencil placed on it The wheel was then speeded up until the block carrying the pencil would slide off and trace its own path on the paper The wheel was run in a counter clockwise direction as indicated by the arrows on the central circle. The block starts to slide off along the radius of the wheel, but soon falls behind as shown in the curves of Fig 1 Traces of the paths are shown starting near the center, and also starting about half way out from the center Curves 1, 2 and 3 represent different accelerations or rates of bringing the wheel up to speed. Curve 1 is the path of the moving block when the wheel is very slowly brought up to speed and curve 3 shows it is quickly brought to the speed at which sliding starts In all these curves the motion is represented with respect to the wheel, which is itself in motion, and taking any radius of the wheel we see that with respect to this line a body sliding on the wheel continually slides backward If now, as in Fig 2, the curves are drawn with respect to a fixed system, say the earth, instead of the wheel, which is moving we get an entirely different set of curves showing that when the body begins to slide it starts on a spiral but while the motion of the body with respect to the wheel was backward, with respect to the earth it is forward The curves in Fig 2 were drawn by placing the block bearing the pencil on the wheel, but pointing the pencil upward and having it attached to a spring to make it press against the lower side of a sheet of paper fastened to a fixed plane above the pencil Inasmuch as the curves of Fig 2 are, as it were inversions of those of Fig 1 it is only necessary to reverse the motion of the wheel in order to obtain with the second arrangement tracings similar in character to those prepared by the first method.

Multi-Cipher Device

JAMES TREVOR in the *Aust Min Stand* describes a multi-cipher device devised by him and shown in an accompanying illustration This device consists of two cylinders mounted loosely on an axle but so arranged that they can be securely clamped together in any position The axle rests in standards on a base



MULTI CIPHER DEVICE

board In the illustration A is the cylinder on which are the code words B the one on which is the key to the code C is a handle for aiding in turning the cylinders In case one pair of cylinders is not enough other pairs of cylinders can be mounted on the same axle A certain phrase in the key is always selected as the one opposite which the keyword of the code is to be clamped Each message is prefaced by a key word so that for each message the code is changed. This prevents easy deciphering of the code used and the message can be read more easily than if a book has to be used.

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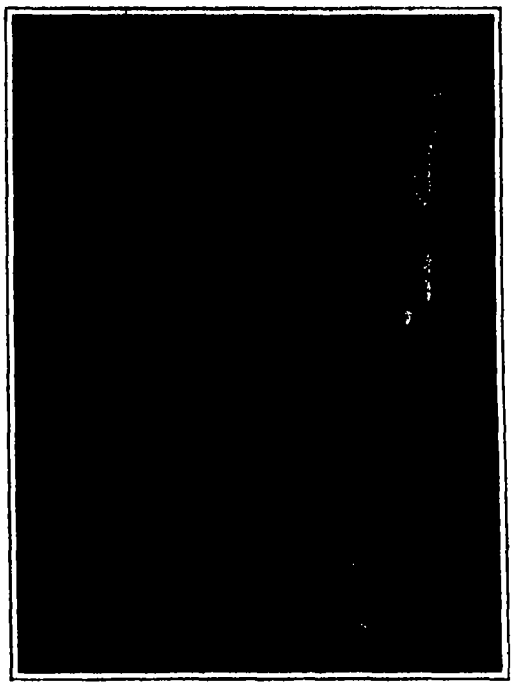
Excavations at Susa

By Our Paris Correspondent

The remains at Susa interest us in more ways than one for this city was not only one of the leading capitals of the Persian Empire and for a long period the residence of royalty but also figured as the scene of the biblical story of Esther and Ahasuerus. The site is now covered by immense mounds which rise above the surrounding desert plain We should no doubt know a great deal more about it but for its isolation in the far interior which renders it difficult of access and makes the transportation of finds extremely difficult M Dieulafoy an eminent Paris archæologist was the first to discover any important remains at Susa and some of the results of his work have been selected as the subject of this article

According to M Dieulafoy s description the city must have presented an imposing appearance as viewed on approaching it from the surrounding country with its royal acropolis a great fortified place situated on a height above the rest of the city Here the walls and towers built of sun dried brick rose to thirty times a man s height. After passing through the city and the commercial quarters we follow a wide avenue which leads up to the acropolis The fortifications were surrounded by a moat which took its water from the neighboring Choaspes stream No less than sixty feet thickness was given to the brick walls so as to furnish the strength to withstand the shocks of battering rams Spaced around the walls were watch towers and postern gates and a main gate at the front gave access to the interior This gate was flanked by two projecting towers as we see them in fortifications of the Middle Ages and there were also covered porticos here which served as the center of life outside the palace We may imagine Mordecai sitting under the portico according to the Bible story waiting to communicate with Esther who occupied the women s apartments in the King s palace within the walls

After passing the great gate we come to a high tower resembling the donjon of our early fortresses This formed one corner of the outer work being however separated from the main walls by a space so as to be better protected This part however remains to be excavated No doubt it served as a last refuge for the soldiers and inhabitants of the royal city where they could flee for protection in time of danger Farther on is a large central space which was originally the great central square or parade ground Around the square were various structures On one side is the Citadel occupying another point on the fortification walls and dominating with its great towers the rest of the work It was shaped somewhat like the Assyrian forts with which we are familiar On the other side of the square is the King s private palace containing the women s apartments where Esther lived We do not know as yet whether any parts of the ancient buildings remain as there have been no excavations made here up to the present time Opposite is the great throne room



CAPITAL OF COLUMN IN THE THRONE ROOM AT SUSA

A FRIEZE FORMED OF FIGURES REPRESENTING ARCHERS SUSA

FRIEZE OF LIONS AT SUSA

MODEL OF THE THRONE ROOM

EXCAVATIONS AT SUSA

which is shown in our illustration and which deserves special mention as it was on this spot that M Dieulafoy carried out most of his work The structure lies on an elevated space and covers much ground A great double staircase led up to it from the square with balustrades of enameled brick in handsome designs and colors and the steps were wide enough to accommodate thirty men abreast and even horsemen could mount them At the bottom and also at the upper level were high gates or pylons adorned with a handsome decorative border of lions in enameled brick Beyond the gate were gardens very tastefully laid out with trees and flowering plants and we may suppose that a gay array of brilliantly colored tents set up with cedarwood poles and fastened with silver rings were scattered over the landscape

Especially striking owing to its vast proportion is the *apadana* or throne room which was used by the Persian kings for special occasions Here the King held his court and received tributaries or ambassadors from surrounding nations Enough of the remains of this large building were found to give a very good idea of what it looked like in ancient times and the model shown in our illustration has been prepared in accordance The building was almost an open structure and had a central hall surrounded on three sides by porticos upheld by columns The entire building covered about half an acre Six ranges of great columns made from the gray stone of a neighboring quarry upheld the roof of the principal part The columns were no less than sixty feet in height One of the capitals of the columns was found almost entire and is shown in our engraving It was brought to Paris after much labor as this great mass of stone was very difficult to transport

The roof beams are supported on a double figure of gray stone representing kneeling bulls In the original state the horns and ears were no doubt of gold but they are now restored in copper The general treatment of the capital is a combination of Egyptian, Greek and Chaldean styles. Near the roof, all around the building, ran a wide frieze representing a long file of lions inclosed in a decorative border A part of this frieze was found sufficient to piece together a few entire panels in an excellent state of preservation This exceedingly handsome frieze is shown in one of our illustrations. The lions are represented between borders having a lotus decoration and are remarkably executed in molded brick colored alternately with different enamels The colors in the frieze are white yellow blue and green and the background is a soft turquoise blue so that the whole design gives a very rich effect. As enamel colors hardly change at all with time we have the frieze in almost the same state as in the ancient period The front of the throne room has no doors and it is likely that curtains were hung down in the spaces between the columns so as to shield the inside from the sun and these could be raised or lowered to give shade when it was needed

Oriental magnificence was not spared on the inside of the throne room to judge by the remains which were found on the spot. It was lined with a red stucco but no doubt the walls were nearly or quite covered with tapestries of the most gorgeous colors In the niches of the walls were gold and silver vases and like ornaments Some of these were gifts made to the King by tributary nations such as the gold plane tree presented to Darius by the satrap of Phrygia

Cedar of Lebanon formed the roof beams, and this was incrusted with gold and mother of pearl leaving the wood also visible as at that time cedar was counted as a precious wood and was no doubt treated by [illegible] were brightly colored, carpets [illegible] with men and animals, hunting scenes [illegible] The King sat under a dais upon a carved [illegible] and held a scepter in his hand. Amid all [illegible] nificence sat the descendant of Darius and [illegible] ruled at that time over all the neighboring [illegible] including Persia Chaldea, Asia Minor [illegible] The King was recognized as the elect of the [illegible] Ormazd and the remains of an inscription [illegible] a dedication to this divinity were found on the [illegible]

The present building was erected by [illegible] Memnon and lies on the site of a more ancient building of the time of Darius I A part of the decoration of the older structure was also found, among [illegible] a very handsome frieze of enameled brick representing the soldiers of the King's bodyguard These figures of the Persian soldiers or archers are remarkably well executed and the colors are most pleasing. The archers hold a short javelin before them and on their shoulder carry bow and quiver According to the ancient writers the Persian kings had in addition to their foot guard a special bodyguard of 10 000 men called the "Immortals Of these 9 000 had iron headed javelins with silver pomegranates at the end, a description which corresponds strikingly with the figures shown on the frieze The remaining 1 000 men were a special select corps and carried spears with gold pomegranates

As regards the story of Esther and Ahasuerus (Darius I) it is to be remembered that the events in question took place before the present *apadana* was built However the archers frieze belongs to that period as it was part of the earlier building Perhaps the remains of other buildings of the period mentioned in the Bible still exist in the parts which remain to be explored

Radiant Energy and Matter—II*

Sir J J Thomson's Royal Institution Lectures

Continued from Supplement No. 1849, page 364

IN opening his second lecture Sir J J Thomson said that he has on the last occasion discussed some views which had been put forward to explain whence the sun derived the enormous energy it radiated which according to various estimates ranged from 10 000 to 15 000 horse power per square foot of its surface

The radiation from the sun Prof Thomson proceeded traveled away through space, a small portion of it falling on the planets Of the energy they were thus continuously acquiring the planets saved but a small amount The earth for instance did not retain any appreciable quantity giving it back to space again also in the form of radiant energy

It was possible to form an estimate of the temperature a body would acquire under the influence of the suns radiation if it lost just as much energy as it received Prof Poynting had thus calculated the temperature of the different planets on this hypothesis In this calculation there were some uncertain factors particularly as to the quantity of radiation reflected In the case of the earth this was an appreciable amount Making however the most probable allowances and estimates it appeared that Mercury would have a temperature of 467 deg absolute or 194 deg C Venus one of 368 deg absolute or 95 deg C while the corresponding figure for the earth was 290 deg absolute or 17 deg C In this case the calculation could be checked and the figure given represented very well the average temperature of the earth Calculated in the same way the temperature of Mars came out as − 38 deg C or far below the freezing point of water This appeared unfortunate for the canals but he believed that Mr Lowell had ways of meeting the difficulty The temperature of Neptune calculated in the same manner was [illegible] deg C so that this planet presented exceptionally favorable conditions for the conduct of low temperature research In this connection the question also arose as to what would be the temperature of a body exposed to starlight only Astronomers estimated starlight as equivalent to [illegible] of bright sunlight and taking this as the basis of the calculation it appeared that a body exposed solely to the radiation of the stars would acquire a temperature of 10 degrees absolute

The main portion of his last lecture he proceeded had been devoted to showing the connection between the total amount of radiation given out by a black body and the absolute temperature of that body All the most recent experiments showed that the amount of energy radiated per square centimeter of surface could be represented by the $5 \cdot ? \times 10^{-5}\theta^4$ ergs per second The erg was a convenient unit for purposes of calculation but was too small for engineering purposes one erg being about the amount of energy exerted by a common house fly when it crawled up a window pane a height equal to the breadth of ones finger nail

The expression above given for the radiation from a black body had been applied in a most ingenious way to the measurement of the temperature of furnace fires and the like by means of the Féry pyrometer In this instrument the light from a furnace was focused by means of a mirror onto a thermopile which thus received a fraction of the total radiation emitted by the body to which it was directed It was thus necessary merely as it were to look at a furnace with the instrument in order to determine its temperature As he had stated last time the fourth power law had originated in some calculations made by Stefan on some experiments made long ago by Tyndall It had since been shown that this law was the only possible one in accord with thermodynamics

This conclusion resulted from a consideration of the pressure due to light In fact all radiant energy exerted a pressure on a body which absorbed it This was almost self-evident when light was thought to be a stream of small particles moving with great velocity If such particles were absorbed by a body the latter would be pushed forward the effect being equivalent to a pressure exerted on the body When the undulatory theory was introduced however it was not clear that there would be any similar pressure if light were a wave motion In fact, this very point had been taken as a crucial distinction between the old and the undulatory theory The experiment had been tried by Bennett who allowed light to fall on a delicately suspended disk and fortunately perhaps for theory, had failed to detect any motion We now knew that had more delicate methods been adopted the result would have been different but had this been the case the experiment would have been almost a death blow to the undulatory theory It was not till long afterward that it was shown that on the electro-magnetic theory also radiation must exert a pressure on bodies which absorb it.

It was somewhat remarkable that many of the more recently discovered properties of light were in many respects more easily explained on the old corpuscular theory than by means of its successor and this question as to the momentum of radiation was an instance in point Maxwell however, showed that if light were an electro-magnetic disturbance a beam of it must possess a certain amount of momentum in the direction of its motion, and was accordingly in this regard mechanically equivalent to a stream of particles Hence when light was absorbed all its momentum was communicated to the absorbing body as a pressure This was not likely however to lead to any practical inconvenience On an average-sized man standing in full sunlight the total resultant pressure only amounted to about ½ milligramme It was indeed a great triumph that these excessively small effects should have been demonstrated and measured within a few per cent, with laboratory apparatus in which the total force acting was but $\frac{1}{5000}$ part of a milligramme

The effect in question Prof Thomson proceeded, must be distinguished from that which caused rotation in Crookes radiometer When this was first invented the effect was believed to be due to light pressure, and the instrument was sometimes referred to as a mill driven by light Further work showed that the forces in operation had a different origin the motion observed being due to the communication of momentum between the hot plates of the rotating part and the colder walls of the containing vessel It was the lecturer proceeded easy to distinguish between a purely domestic affair of this kind and an effect due to an external cause such as was the pressure due to light In fact any effect due to the action of the glass in pushing particles of air against the vanes could not produce rotation of the apparatus as a whole a self-contained system being incapable of acquiring momentum It would be as impossible for the radiometer effect to produce rotation of the instrument as a whole as for the passengers facing the engine in a train to assist in propelling the latter by hitting those on the opposite seats Action was balanced by reaction and if the vanes moved round in one direction, then the casing if freely suspended, would turn in the other To show that this was indeed the case, the lecturer suspended a radiometer complete from a fine wire When exposed to a strong light the vanes rotated in one direction while the bulb of the instrument moved round slowly in the other

This radiometer effect, Sir Joseph continued was one of the difficulties which had to be got rid of in experiments on the pressure of light. Its effect was very large as compared with the latter Another difficulty arose from convection currents. If the air in the vessel used got warmed, currents were set up, which acted with forces almost infinite in comparison with the light pressure to be measured, These could be got rid of by placing the apparatus in a vacuum, but this made the radiometer effects worse. The problem was thus a difficult one. The radiometer effects could, however, be avoided by taking advantage of the fact that they were purely a domestic affair and that if the vane were [illegible]

* Report of Sir J J Thomson's lecture reproduced from *Engineering*

[illegible] containing vessel they would cancel out [illegible], the lecturer continued, in the apparatus [illegible] Prof. Poynting In this the vanes [illegible] the pressure of light were rigidly [illegible] their mica case, the whole being suspended in a vacuous vessel from a quartz fiber The mica [illegible] very little of the radiation and its temperature therefore remained much the same as that of the outer vessel On exposure to light the pressure on the vanes caused the whole of the mica vessel to deflect, the amount being measured by a spot of light reflected from a mirror

The pressure due to light was the speaker continued, first detected by the Russian physicist Lebedeff, and a little later Nicolls and Hull succeeded in getting a very satisfactory agreement with the predictions of theory On the theory that light consisted of a stream of particles there was also a pressure produced but different in amount, so that the experiments made served to discriminate between this theory and the electro-magnetic theory With the former the pressure produced would be just twice as much as with the latter Hence if we could trust our experimental results within a margin of 50 per cent, it was possible to determine which theory best satisfied the experiments Messrs Hull and Nicolls found their results in close agreement with the requirements of the electro-magnetic theory the difference not amounting to 10 per cent

Since light exerted a pressure it was possible to conceive of an engine operated by this pressure The amount of power produced might not be at all formidable and would make no show in the industrial world, but all such engines whether large or small were subject to the same laws since there was not in thermodynamics one law for the rich and another for the poor Suppose then a cylinder fitted with a piston and filled with light instead of with gas This light would exert a pressure on the piston Calling the energy of the light per unit volume E then the pressure per square centimeter on the piston was numerically equal to 1/3 E by the electro-magnetic theory while in the case of a gas filling the cylinder it would be 2/3 E

Suppose now the piston was allowed to rise so as to alter the volume below it by the amount v^1 Then the work done would be $p v^1$ At the same time however, in order to fill up the space left behind and thus keep the temperature constant energy equal to E v_1 must also be supplied

Hence the total supply of energy must be

$$p v^1 + E v^1 \text{ or since } p = 1/3 \text{ E}$$

we had

$$p v^1 + E v = 4 p v^1$$

But it was shown in thermodynamics that in that case we must have*

$$4 p v^1 = \theta \frac{dp}{d\theta} v^1$$

$$\text{or } 4 p = \theta \frac{dp}{d\theta}$$

where θ denoted the absolute temperature

Integrating this gives $p = 1/3 \text{ E} = c T^4$ which was the fourth power law

The existence of this pressure due to radiation had Sir Joseph continued been put to a great many uses as an explanation of phenomena Thus it had been supposed sufficient to account for the existence of comets tails and Arrhenius had suggested that it served to regenerate the available energy of the universe now being continually dissipated in various ways For his own part he thought a little too much had been made of the fact that light produced a pressure and that the application of a little cold arithmetic would show that the hypotheses framed were hardly warranted by the facts

As for comets s tails it was of course true that light from the sun would exert a pressure on small opaque bodies which, if sufficiently minute might be repelled in spite of gravitation Gravitational attraction was proportional to the volume of a body while the light pressure was proportional to the surface Hence if the bodies were made smaller and smaller we must at last come to a size when the repulsion due to light would exceed gravitational attraction For this repulsion to come into play however the light must be absorbed If the particles were transparent, there would be no repulsion If a comet s tail consisted of dust then no doubt, the light pressure would sweep out this dust from the doorsteps of the sun If however the tail were gaseous, then to get the gravitation balanced by the light pressure this light must be absorbed It could be shown that the light pressure due to the sun was one ten thousandth of a milligramme per square centimeter and hence if 1 square centimeter had a mass of one-tenth of a milligramme behind it, the light pressure would just balance the attraction Hence 1/10 milligramme must suffice to absorb all the light incident on 1 square centimeter No gas was however known which was capable of doing this Hence if the comet s tail were gaseous one could hardly conceive that its repulsion was due to the pressure of the sunlight

This pressure of light formed an excellent illustration of Le Sage s theory of gravitation which assumed that all masses in the universe were being bombarded by particles coming from all directions Each mass would therefore shield its neighbor from some part of the bombardment it would otherwise receive and hence the two would be impelled toward each other The same kind of thing happened in the case of radiation pressure Two cold bodies placed within a warm inclosure would each shield the other from a certain pressure it would otherwise receive from the radiation from the walls and the two would tend to move as if attracted to each other If on the other hand the bodies were hotter than the inclosure they would repel each other Prof Poynting had thus shown that two globes each of 20 centimeters radius and at the temperature of boiling water would if radiating freely into cold space repel each other with a force exactly equal to their gravitational attraction It might be asked he continued whether this effect was not a serious thing for experiments on gravitational attraction and undoubtedly it would be so if the walls of the inclosure in which such experiments were made were much cooler than the apparatus experimented with In the actual conditions of the experiment however the radiation pressure canceled out

(To be continued)

* Engineers will recognize the equation better in the form

$$v\,dp = L \frac{d\theta}{\theta}$$

the well known relation between the specific volume of steam and its latent heat This gives $L = \theta \frac{dp}{d\theta} v$ and L being the total energy added at the temperature T is the equivalent of $4 p v^1$ above

Fixing the Day of the Week of Previous Dates

Some Curious Rules and Their Application

By Robert Grimshaw

In combating the erroneous idea that Friday is an unlucky day, and in advancing the fact that for America it has been a particularly lucky one—if there be any such thing as luck—any one who will look up American history from the date of Columbus s sailing to the important battles in Mexico and elsewhere will be convinced that Friday and thirteen are for us lucky I incidentally stumbled upon the method of determining the day of the week on which a given date fell—a system of calculation which is employed by the lightning calculator Leo Erichsen on the German variety stage and which as it is probably new to most of the readers of this periodical, I present in detail

In the ordinary year of 365 days there are 52 weeks and one day over which latter extra day renders more difficult the determining of the day of the week in times gone by—a difficulty which is increased by the presence of the extra day of the leap year and still further by the absence of this extra day on certain even hundreds of years From this arrangement that the year ends on the same day of the week as that on which it begins springs the catch which is usually successfully employed as a bet—that this year Christmas and New Year s Day do not fall on the same day of the week.' Naturally for the New Year's Day" of which the victim thinks is not in the same year as the Christmas in question but in the next

Now if the year 1 of our Lord began on a Saturday the year A. D 2 began on a Sunday, and A. D 3 on a Monday After seven years of 365 days each, the same order occurs again So we start with the fact that the year 1 began with a Saturday The same is true of the year B C. 10001, which astronomers call minus 10000

In dividing by seven the number of the years of 365 days each since the year 1 of that period we have as remainders for Saturday 0 Sunday 1 Monday 2 etc. But the occurrence of leap year complicates the matter The number of days which have been "inserted" by the extra day of February is ascertained by dividing the number of the year by 4. This is good all the way through for the so-called Julian calendar, which is still in use and force in Russia, Bulgaria and Servia. But according to the Gregorian calendar by which we now reckon and which was introduced by the papal bull of 1582 October 6th *Inter gravissimas* there were cut out from the date mentioned until 1700 ten days for the eighteenth century 11 days for the nineteenth 12 and for the twentieth (our own) 13 from the Julian calendar This is to be considered after dividing the number of the year by four Therefore when we calculate the day of the week of the year A D 1 must be thrown back one day a year more from Saturday of the year 1 further by one day for each leap year and if the date according to the Gregorian calender is desired the number of the missing days is to be subtracted from the date according to the Julian calendar The result of the calculation determines the number of weeks which have elapsed from January 1st up to the date in question This is the only part of the calculation which requires any act of memory on the part of the lightning or other calculator He must keep in mind that on the 0 day of each month [illegible] January 1st there have elapsed in January 1 day, in February 30, March 58 April 89 May 119 June 150 July 180 August 211 September 242 November 303 December 333 days (With the aid of the ordinary mnemotechnic rules these numbers will not be very difficult to retain in the mind) It is easy to see that on the 16th day of January 15 days have elapsed since January 1st on November 7th 310 etc.

The practical application of the rule is much more easy than it would at first seem in view of this theoretical discussion First 1 is to be subtracted from the number of the year and the remainder divided by 7 The remainder if any of this division is called the first remainder Then the undiminished whole number of the year is to be divided by 4 From the quotient (which for dates before February 29th is to be lessened by 1) the number of missing days according to the reformed or Julian calendar is to be subtracted This difference is to be divided by 7 and the remainder if any called the "second remainder" Finally the number of days since January 1st is to be divided by 7 and what is over, if any, then called the "third remainder The three remainders are to be added together and the sum divided by 7 so that at last there is a final remainder which will be one of the numbers 0 to 6 inclusive If this final remainder be 0 the day of the week was Friday if 1 it was Saturday and so on

As an example we take the date 1628 January 28th (this order being chosen for convenience) 1611 1 = 1610 1610 − 7 = 230 first remainder 0 1611 − 4 = 402 The number of missing days for the seventeenth century is 10 then 392 − 7 = 56 with no remainder so second remainder is 0 On January 28th there were 27 days elapsed since January 1st the third remainder after dividing 27 by 7 is therefore 6 The sum of the three remainders is 6 which shows that the date in question fell on a Friday

Suppose we choose as an example 1423 May 30th 1423 − 1 = 1422 which after dividing by 7 gives as first remainder 1 1423 − 4 = 155 155 − 10 = 145 145 7 = 20 leaving as second remainder 5 May 30th (149 days elapsed) 149 − 7 = 21 third remainder 2 Sum of the remainders 8 then final remainder 1 calling for a Sunday

This method has been known for some time although not to a very large circle A novelty is its application to dates before the birth of Christ as explained by Kretzinger of Berlin To work this out it is necessary to call the year by its astronomical year number that is one less than the number which we give it This number is subtracted from 10 000 and the difference divided by 7 to get the first remainder The same difference is then divided by 4 and the quotient increased by 1 because minus 10 000 was a leap year Only in such years it remains up to February 28th unchanged otherwise the old rule applies As an example

—2865 B C February 17th

− 2864 + 10 000 = 7136 first remainder 3 7136 − 4 = 1784 (no addition because the date lies before February 29th and the year is not divisible by 4) 1784 ÷ 7 = 254 with 6 as second remainder On February 27th there were 47 days elapsed since January 1st remainder 47 ÷ 7 = 5 Sums of the remainders, 3 + 6 + 5 = 14 final remainder (after dividing 14 by 7) 0 Therefore the day of the week would have been Friday

The Alteration of Checks*

How Alterations are Made in Spite of Safety Tint Paper and Check Punches

By William J Kinsley

If all forgers were as skilful as painstaking and astute as was Charles Becker of Brooklyn when in 1896 he raised a draft of the Bank of Woodland California on the Crocker Woolworth Bank of San Francisco from twelve dollars to twenty two thousand dollars the protection of banks against alterations would be almost impossible—particularly so when drafts and checks are cashed in the rather hurried manner almost unavoidable in the rush hours

So artistic was Becker's alteration of this twelve dollar draft that a careful examination under the microscope was necessary for its detection The draft had been duly protected with a check punch but paper was chewed into a plastic pulp-like mass the old perforations were filled and these fillings were hardened and ironed The draft was on a safety tint paper but this did not prevent the erasure of the amount by means of acid the surface and tint being restored thereafter by means of water color The raised amount was then inserted in letters and figures new perforations to "protect" the twenty-two-thousand dollar draft were made with a hand punch and the raised draft was complete

The altered draft was cashed without exciting suspicion and without unusual difficulty and before its fraudulent nature was discovered Becker had disappeared It was only after a two years chase all over the United States that he was finally located and arrested in Newark New Jersey On his first trial the jury disagreed but at the opening of the second trial Becker pleaded guilty and was sentenced to two years imprisonment in the California State Prison

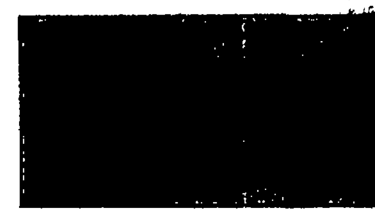
Upon the completion of Becker's sentence he returned to his former home in Brooklyn. I have been informed by one of the officers of a safety paper company that since then Becker applied [illegible] a position as salesman and demonst[illegible] the *advantages* of using safety paper for [illegible] drafts It is needless to say that he wa[illegible].

The Work of an Artist

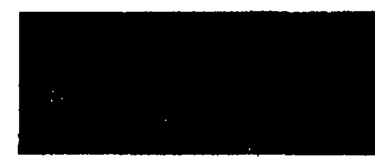
Probably the best educated and most [illegible] in the United States is Alonzo J Whit[illegible] now completing an eight year term in the Auburn New York State Prison for raising a draft drawn by the National Hudson River Bank of Hudson, New York on the Mechanics National Bank of New York city The draft was drawn for nine dollars It was raised to nine thousand dollars.

Preparatory to this transformation Whiteman purchased several small drafts from the National Hudson River Bank Experiments were then made with different acids to ascertain their effect when erasures were made. On two of the drafts the acids evidently failed to work properly, discoloring the paper. These damaged drafts were first burned sufficiently to efface the incriminating discolorations and were then returned to the bank by Whiteman or his confederates for redemption, with an explanatory [illegible]

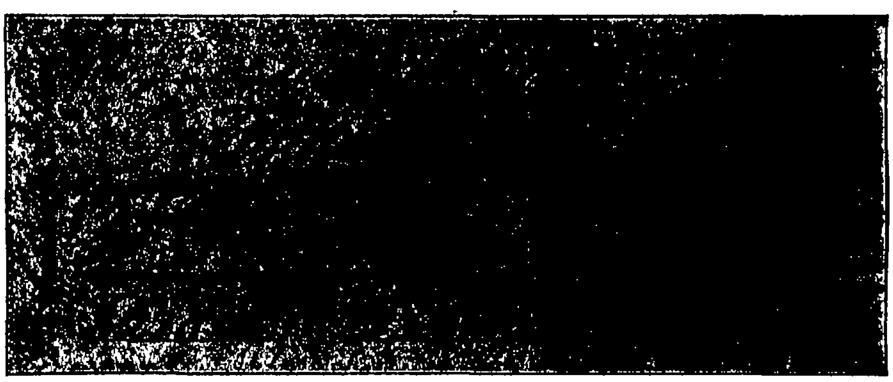
A DRAFT ORIGINALLY FOR TWELVE DOLLARS RAISED TO TWENTY TWO THOUSAND DOLLARS



RAISED FROM ELEVEN TO SEVENTEEN*

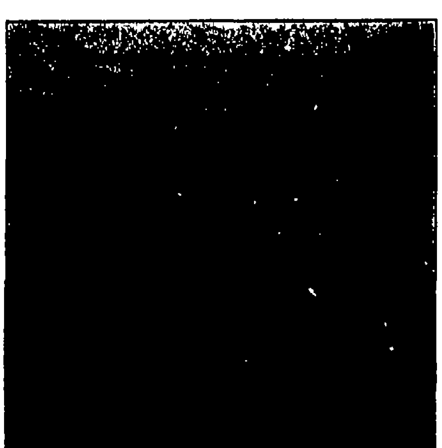


ARTISTIC CHECK PERFORATING ORIGINAL HOLES FILLED AND NEW AMOUNT PUNCHED*



RAISED FROM TEN DOLLARS TO TWO HUNDRED AND TEN DOLLARS

RAISED FROM FIFTEEN TO TWENTY THREE*



BOND WITH ORIGINAL SIGNATURE ERASED AND NEW SIGNATURE INSERTED

THE UPPER DRAFT HAS BEEN RAISED FROM NINE TO NINE THOUSAND DOLLARS THE LOWER DRAFT WAS DAMAGED IN AN EXPERIMENTAL RAISING AND WAS REDEEMED BY THE ISSUING BANK*

* *The Business World.*

* The illustrations marked (*) are from photographs made by Albert S Osborn Examiner and Photographer of Documents, New York.

[illegible] that the papers had been accidently burned by [illegible] ashes. The drafts had undoubtedly been burned and the bank very obligingly redeemed them both. The illustration on the preceding page shows one of the damaged drafts.

Whiteman's next attempt was evidently successful. Once one of the drafts originally for nine dollars but now raised to nine thousand dollars was shortly thereafter deposited in the Fidelity Trust Company of Buffalo, New York—where an account was opened—and a large part checked out before the fraudulent nature of the draft was discovered.

Whiteman fled but was arrested some six months later in St. Louis. While on his way home for trial he jumped from the window of a Pullman car within a few miles of Buffalo and made his escape. He fled to Mexico but later returned to his home in Dansville, New York, where he was again arrested. He was convicted in October, 1905, by Assistant District Attorneys Frank A. Abbott and John W. Ryan of Buffalo, and was sent to prison for a term of years.

I testified at Whiteman's trial. While securing autographs of the attorneys in the court room at the close of the trial Whiteman came over and said: "I know that you want my name," and put his autograph in my book as though proud to have it there. He seemed to feel no animosity for my part in his conviction.

After Whiteman had been in prison about a year I met his attorney and as a matter of curiosity asked him what work Whiteman was doing in jail.

The attorney replied "Teaching." I asked "Teaching what?" and the attorney replied "Business."

Common Methods of Raising Checks

There are various methods of raising checks. One of the commonest is to take advantage of spaces either before or after the original writing. If space is left to the right of the amount terminal letters or figures changing the amount are easily added. Thus a check drawn for seven dollars is, if moderate space has been left to the right, readily raised to seventy. Likewise if there is space at the left of the amount it may easily be raised by the insertion of the proper words and figures. Thus a check for five hundred dollars is by the insertion of forty, fifty, etc., in space at the left readily raised to forty-five hundred, fifty-five hundred, etc.

A Forgery or an Alteration

This method has been followed on occasions with much success. In the Bickart check shown in the accompanying engraving the depositor claims the signature is a forgery, while the bank claims that the signature is genuine, but that the amount has been "raised" from ten to two hundred and ten dollars—in the same handwriting. The writer of the body of the checks (who also cashed them) is serving a sentence in Sing Sing Prison for his part in the work.

Wholesale Alterations

In a recent case dozens of checks were put in evidence which the depositor claimed had been variously raised from six, seven, eight and nine dollars to larger amounts by adding 'teen' to them. The checks, both as to the original amounts and the raised amounts, were all in one handwriting, and it was charged that the bookkeeper made the changes after the depositor's signature had been affixed. This was, of course, a comparatively easy thing to do, but a fraud very difficult of detection.

Other Methods of Altering Checks

Another method of altering checks much in vogue is the actual change of the amounts themselves. Badly bungled examples of this method are shown in the accompanying half-tones, the change of amount from eleven to seventeen in the one and from fifteen to twenty-three in the other being easily apparent.

Another method of alteration, or a combination of methods already mentioned—is shown in the accompanying illustration. This is part of a promissory note which originally read two hundred dollars. A close inspection will show that a capital "T" was placed before the small "h" in "hundred" and the "hundred" altered so that with its prefixer "T" it reads "Thousand." An additional cipher added to the figures completes it.

Alteration of Check by Maker

Frequently checks are altered by bodily adding something to them after they have been returned to the depositor from the bank. It is of course but seldom that the amount of the check is changed in such a case. Usually the additions are explanatory of the supposed purpose of the check, as, for instance, "In full of account," "In full of all demands," "For interest on note," etc. In one such case I discovered that the pen in adding the words "In full of account" had slipped into one of the punch holes in the cancelling "Paid" perforated by the bank. As this cancelling perforation was of course made after the check had been paid, the ink marks inside the edges of the punch hole were proof positive that the writing was added after the check had returned to the depositor's hands, and not before as the depositor would have had the court believe.

ALTERED CHECKS. ORIGINAL NAMES AND AMOUNTS REMOVED BY MEANS OF CHEMICALS.

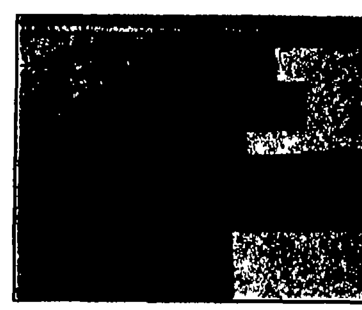
Another case hinged on whether the sentence "In payment one gray horse to be right in every way" was written in its entirety at the time the deal was made, or whether "to be right in every way" was inserted at a later date. The entire sentence is concededly in the same handwriting, is written with the same ink and probably with the same pen, but it was claimed by the defendant in the case that the phrase "to be right in every way" was added the day after the preceding words were written. A reproduction of the disputed sentence is shown in the engraving. Notice the difference in quality of line and slant between two portions of the sentence.

A Daring but Successful Method of Alteration

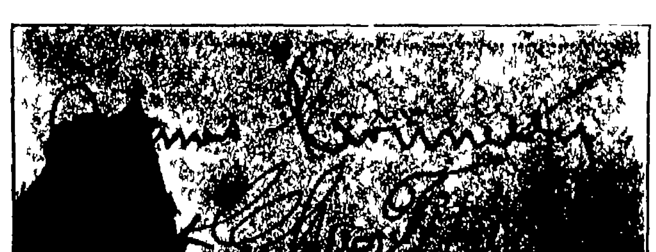
One of the most successful methods of altering checks is to erase the entire amount—both letters and figures—and then to replace it with any sum that suits the artist. This method is extremely difficult of detection if skilfully done and is applicable to any kind of instrument. Even on safety papers a portion of the face of the check can be washed off by

ORIGINAL SIGNATURES ERASED AND OTHER SIGNATURES SUBSTITUTED.

ENDORSEMENT ADDED TO AT A LATE DATE.



FROM $1.50 TO $1150. NOTE IRREGULAR PERFORATION.



ENLARGED SIGNATURES TO BOND SHOWN ON PRECEDING PAGE. ERASED SIGNATURE RENDERED VISIBLE BY PHOTOGRAPHY.

A NOTE ORIGINALLY FOR TWO HUNDRED DOLLARS RAISED TO TWO THOUSAND DOLLARS.*

acid the check be re-tinted as necessary and then the desired amount be written in This was the method pursued so successfully in the case of the Becker draft already mentioned

The Value of Check Punches

Check punches while useful as a general protective measure do not have any strong restraining influence on a professional check raiser If you wish to know why ask the agents of a check punching mechanism to show you how they can raise checks punched by a rival machine

The illustration showing the perforated $2 400 is a good example of a raised perforation It was made from a photograph taken by transmitted light in order to show the original holes—now filled in—and the new perforations made thereafter A casual or even careful examination under any ordinary conditions would not disclose the existence of the filled perforation

The eleven hundred and fifty dollar check shown in another illustration is another example of a raised perforation The original check it is claimed read One hundred fifty dollars this amount having been altered to read Eleven hundred fifty Notice the bad alignment of the punched figures

Bad Writing as an Obscuring Element

Indistinct writing sometimes plays as troublesome a part in obscuring the essential details of checks and others instruments as do actual alterations confusing amounts intention and even ownership

Some years ago I was consulted in a case of this kind The question to be determined was whether or not the name in a deed as recorded was Erving or Ewing Jones The original deed had long since been lost The recording clerk was dead There had been both an Irving and Ewing in the family The descendants of both claimed the property The difficulty lay entirely in deciding whether the writer had made the first part of his w like an r or had made an r like the first part of a w As the writer did not make the broad top r or a distinctive r with the shoulder it was very difficult to determine whether the property had really been deeded to Erving or Ewing An exhaustive comparison of the recorder's handwriting was necessary before the real ownership of the property could be finally established

Alterations for Purposes of Concealment

Occasionally the endorsements of checks drafts and vouchers are altered either to cover up some thing or to comply with some condition on the face of the paper

Thus in an investigation conducted in the office of the Borough President of New York some years ago several vouchers for carpenter work were found which had gone through the Controller's office with very palpable erasures of signatures and over writing of signatures In one instance shown in the illustration the camera brought out the signature as Boyce This was the real name of the party who signed but his signature was affixed inadvertently It was intended that he should sign a fictitious name To leave the signature would have clearly shown that the contractor and an official in one of the city departments were one and the same This was not desired hence the original signature was erased and the name Thomas A Tydings was written in its place The original endorsed signature had also been erased and the name rewritten in a different hand for somewhat similar reasons

The Detection of Alterations

In determining whether or not checks drafts or other papers have been raised or otherwise altered microscopical examination and comparison of the ink used in the written portions of the instrument will frequently determine whether or not more than one ink has been used The fact that different inks were used in different parts of the check or other paper is not of course proof positive of fraud but in the case of a suspected instrument is very strong presumptive evidence

A microscopical examination of a doubtful instrument will often determine whether or not the calendering of the paper has been removed also whether or not anything has been applied to the surface of the paper Photographs both by direct and transmitted light will frequently disclose things not observable even under the microscope

Where chemical erasures have been made and some of the original ink remains in the fibers of the paper this ink—if it contains iron—may be partially restored by exposure to the fumes of acid in a tightly closed box This restoration of the original writing is only temporary fading in an hour or so but it may be repeated as often as desired While in the restored state the original writing may be photographed and thus be permanently preserved

Time as a Detective Agent

When erasures on papers have been made by means of chemicals, these erasures can be, and frequently are so well done as to defy detection at the time But if the paper is examined again in six months it will usually show a decided yellow stain. And if photographed the photo-print will disclose the stain emphasized as the ordinary photographic plate is sensitive to yellow

The Freedman checks shown herewith are good examples of chemically erased checks, photographed three years after the erasures were made There were some thirty of these checks, amounting to about $25 000 The bookkeeper altered them by erasing the payee's name and substituting his own and occasionally by raising the amount In filling out these checks originally the bookkeeper (who confessed to altering the checks and who has served a term in prison for the crime) wrote the payee's name or the amount whichever was to be changed well above the base line This when erased left the usual place for the name or amount clean and unaffected so that the new matter could be written in with a free hand without danger of blots or roughnesses

In the writing on one of these checks shown herewith it is very difficult to discover any alteration while in the other shown in the same illustration it is plainly observable

Where erasures by mechanical means—abrasion for example—are made on papers that have been much handled or when a considerable time has elapsed since the erasures were made they are much more easily detected than is otherwise the case

The case of the State of New Jersey vs James Connolly hinged—not on an altered check but on substantially the same kind of erasure as is used in the alteration of checks The alteration here consisted of the chemical erasure of a signature on a bail bond The defendant was indicted for giving real estate which he did not own as security for a bond He denied that the signature on the bond was his And upon another inspection it was found that the name James Connelly —as it now appeared—was not in the handwriting of the defendant As was discovered later it was a new signature which had been written over a chemical erasure. In addition to this a blot partly obscured the writing and made the work of discovering the true conditions much more difficult

The defendant on his part engaged a handwriting expert who upon comparison reported that the signature as it now appeared was not in his client's handwriting The handwriting expert employed by the plaintiff then made photographs of the page and signature natural size and enlarged and at the trial these were introduced into evidence They showed unmistakably that the original signature was James Connelly but written in a different handwriting from the second James Connelly This original signature as shown in the plate was brought out faintly but distinctly On examination this original signature proved to be the signature of the defendant The expert for the defendants thereupon left the courtroom without taking the witness stand The illustration shown herewith is reproduced from the photograph used in court to prove that the questioned signature was in the defendant's handwriting

The Prevention of Alterations

A good ink a good check punch good safety paper and care in leaving no blank spaces will as a rule prevent raising of checks It may not absolutely prevent alterations but it will discourage the ordinary crooked operator—so much so that before exercising his art he will look around for a more careless writer who does not protect his bank account so well

Lowering a Check

I never knew of but one case where a check was lowered Here the forger stood near the window of a busy New York bank and saw a messenger from another bank present a check for certification The messenger said that he would return in a short time Before his return the forger stepped to the window, called out the name of the other bank and was handed the certified check for some thousands of dollars He had to act promptly and cash the check at once Knowing the difficult of securing so large a sum without identification he altered the check to read Nine hundred dollars, cashed it and escaped He was never caught.

YOUR SIGNATURE AND HOW TO WRITE IT

Identification by Handwriting

Millions of dollars frequently and human lives occasionally are balanced on a pen point

No other record left by man is so peculiarly personal characteristic, and identifying as his hand writing It is better than photographs or body measurements for establishing identity because it bears the stamp of the writer's individuality, his own personal touch It can be recorded in compact form and can be easily filed and kept for reference.

No other nation produces so many good or fast writers as the United States, yet judging by the illegible writing, especially of signatures, we find many business and professional men who, with [illegible] "Hold it a business to write fair, and labor [illegible] how to forget that learning."

A little more care and thought, especially in writing important papers, would save a vast amount of annoyance and even loss.

The three essentials of a good handwriting are legibility, ease of execution and speed. The greater part of the handwriting of this country is produced by the free, forearm movement. This is conducive to grace, speed freedom and ease of execution, but not necessarily to accuracy of form.

Variations of Handwriting.

School children, following the same stereotyped models and practicing and using them under the same conditions write very much alike, and their writing is crude, conventional characterless. A few years out in the world works a wondrous change Conditions and individual temperaments assert themselves making alterations in the handwritings that leave them scarcely recognizable A change of slant or size a lopping off here, an addition there an emphasis on a certain part of a stroke, the adoption of a new type of capitals or small letters—these are some of the things that produce the variations found in handwritings that were originally almost identical.

'There is certainly a peculiar handwriting, a peculiar countenance not widely different in many, yet always enough to be distinctive. —Boswell's 'Life of Dr Johnson"

These variations admit of almost an infinite number of combinations and when these peculiarly personal variations from the normal or conventional styles become a fixed part of the handwriting of the individual, they are known as characteristics" and serve as identifying hall marks or trade marks, as it were

It is by these characteristics or hall marks peculiar to each handwriting that the particular hand writing is separated from all others and unmistakably recognized and identified.

These identifying characteristics are a combination of many conscious and more unconscious repetitions Habits in handwriting may be formed as in other things and by giving thought to it during the formative period we can control our writing and make it good or bad characteristic or characterless

A little study of our handwriting is not only interesting but profitable as well

To-day a thing is hardly considered on the road to doing until it has been put into writing and it behooves us to select what is for us the best style of handwriting and a type of signature that will best protect the bank account and the other valuables safeguarded by signature

The Signature

A legal signature' or sign manual may be an assumed name a title a mark a sign or a pen flourish anything that may stand for or represent the name of the signer Ordinary modern interpretation and usage have construed the word signature to mean the writer's name written by himself Hence the modern signature at a glance discloses (1) the name of the writer (2) his peculiar spelling of the name, (3) the various lines forming a pen picture of the same (4) the writer's own personal technique or touch This in its entirety gives an identifying mark that reveals at a glance suffcent of the writer's character to satisfy a hurried demand, and yields much more on longer and closer inspection Then too 'Age cannot wither nor custom stale' its mark of identity It will be the same to-day to-morrow next year, and until time affects the materials with which and on which it was written

Style of Signature

The object of every penman should be to select a style of signature which while embodying his identifying characteristics is also legible and easily and rapidly written. Such a signature is one which can not as a rule be successfully imitated

Details of Signature

The first thing to consider is the spelling and any abbreviations of the name. If the name be John Henry Jones, it may be written J Henry Jones, Jno. Hy Jones, J H Jones, John H Jones, etc Select some one of these, and having once selected it do not change. It may be noted in passing that distinguished men rarely use abbreviations.

A married woman should sign her own name, Susan R. Brown,' not "Mrs Henry G Brown"

Next select the style of capitals and small letters you expect to use, and do not change because of desire for variety, or because of mere whim or caprice The constant repetition of the same signature will give you skill, and a peculiar touch and technique that will be most difficult for a forger to imitate.

Select the kind of pen suited for your hand and for your writing. There is a wide latitude here; pens are made fine, coarse, stub, stiff or elastic. [illegible]

only caution necessary is to select a pen that will not blur on the angles and short turns and thus hide the points of identity Very broad stub pens are not good and stylographic (one nib) pens should be let severely alone Never write with a lead pencil when any values are involved

Writing the Signature

While banks, as a rule, do not pay paper on the signature alone still it is of prime importance to aid them all you can by giving them a signature that protects them and you at the same time

A legible rapidly written free off hand signature is much harder to simulate than an illegible slowly written or shaky signature To successfully imitate any signature, the imitation must not only possess the correct form but be written at the same speed as the original, otherwise the quality of line will betray the forgery A poor penman cannot forge the name of a more skillful writer because the copy is beyond his skill Forgers usually copy the signature of a poor or slow writer as this requires less skill and gives more time while the pen is *moving* over the paper

This has been found to be true in the majority of cases of forged signatures submitted by banks and attorneys to the writer for professional investigation

So far as you can (and you can at your office) write with but one kind of ink

Do not patch mend or over write a signature This habit may deceive the paying teller when a forged check is presented for payment bearing similar alterations Do not depend alone on some little oddity, dot dash or flourish to redeem an otherwise bad signature and make it a safe one A forger will readily see and imitate such things

Even when the handwriting as a whole is neglected the signature and figures should always be legible since nothing can be judged by context to aid the reader Each figure and each letter in a name should therefore stand out with perfect legibility

A rubric or flourish is a good thing to add to a signature as it is difficult to imitate It should not however be allowed to obscure a legible signature Have a rubric that does not extend too far below or beyond the letters as space on checks is limited The flourishes used to connect the letters in the name may be employed as a rubric

If the initials of a name may be readily gracefully and *legibly* connected it is a good plan to do so Some initials look better not so connected Occasionally making one capital larger than another adds a distinctive touch to a signature

Picket Fence Style

Americans write illegibly not through ignorance or lack of skill but because of a mistaken idea that an odd or illegible handwriting is difficult to imitate or because of lack of time or through carelessness As an example take the picket fence style of signature used by some bankers and business men It is by the general appearance of the picture as a whole that this style of handwriting must be recognized and this fact makes it an easy style to imitate One or two strokes more or less makes but little difference in the pictorial effect

A story is told of the great lawyer Rufus Choate who was as famous for his bad handwriting as for his good law that at a town meeting he threatened to challenge a voter because the man couldn t read but desisted on a bystander s threat to challenge the jurist because he couldn t write

And Horace Greeley s letter of discharge of a composing room foreman for incompetence which because of its bad handwriting was used as a recommendation to secure another job is also famous

Noted men may perhaps be allowed an illegible signature as a characteristic of their renown and a tribute to it but for the ordinary man of business it is not a safe indulgence

The Ultimate Limitation of Mineral Resources

Its Significance to the Human Race

Prof J A Kemp s Analysis

Prof J A Kemp in his presidential address before the New York Academy of Sciences concludes his detailed consideration of the available sources of coal and the principal metals with some very apt reflections of a general character Incidentally he considers the nature of the change which we may expect to come over the present social conditions in the event that at some future time a scarcity should arrive in the supply of certain materials now appearing almost indispensable for the transaction of the great mass of daily business

Of iron ore there is no lack nor need any one be apprehensive regarding the supply of this metal but before very many years have passed the yield of the ore will have decidedly declined While the falling off will be gradual it will undoubtedly tend in the long run toward 40 per cent This change is in itself important because unless otherwise neutralized it will raise the cost of production It makes necessary the melting of more barren materials in the furnace so that the consumption of fuel rises with respect to the amount of iron produced It means also the mining and freighting of an additional burden which yields no return from whatever point of view we regard it other things being equal the cost of production rises

The greatest cause of apprehension as regards present processes of iron manufacture lies in the supply of coking coal We have built lofty furnaces and in their use we place upon the fuel as it progresses downward in the furnace a heavy load of overlying ore and limestone We need a very strong coke to stand up under the burden The coals which yield these high grade cokes are found in a small portion of the total coal bearing area and the life of the supply is one of the very serious phases of the present situation

While these physical and chemical factors operate to increase costs there is always the possibility of improved processes of greater efficiency to keep them down The improvement oftenest in people s minds to-day is the utilization of water powers to generate electricity which in turn may supply heat Now in a blast furnace smelting iron ores one-third the fuel is employed in reducing the iron oxide and two-thirds in developing the necessary heat for the reaction Were we able with water powers to economically furnish electricity and from it derive the necessary heat we might save the two thirds of the present amount of required fuel We might reduce costs The remaining one-third of the fuel we should always need but it is possible that poorer grades than high quality coke might answer The saving would lie of course in the difference between the cost of the fuel and the cost of the electric current, provided the latter could be furnished more cheaply than the former

The water powers in our own country or at least in the more thickly settled portions of it have not failed to attract attention nor have they gone altogether unutilized The more conveniently situated ones are already harnessed to the dynamos But in countries like Norway and Sweden where there are large water powers still available where there are rich deposits of ore and where coal fails the applications of electricity to iron smelting are likely to be first worked out successfully Data may be furnished in the life time of many of us which will cast light upon these improvements in their world wide relations

The only other apparent possibility of reducing costs lies in the labor charges Wages at present are not unduly high and unless the increasing population of the country brings to pass an inevitable struggle for existence which will cause the greater subdivision of tasks at lower proportional returns or unless the general reduction of expenses for subsistence makes lower wages possible there would seem to be slight prospect of change in this item In any event the reductions from this cause cannot compensate the falling off in the yield of iron

Suppose iron goes up in cost other conditions of our daily life remaining the same—transportation and all manufacturing based on machinery would become more expensive and less freely carried on Undoubtedly an appreciable pressure would be developed to turn our people back to the rural districts and to tilling the soil for a livelihood The tendency under the stimulus of manufacturing development has been the other way The migration of late years has been toward not from the cities Shall we perhaps find in the long run in the increasing cost of iron and steel a partial solution of a much vexed problem? Will the cry Back to the soil receive support in a way not generally anticipated? The question is an interesting one for speculation

The general inference regarding copper is that the pinch of higher cost of production will be felt sooner than in the case of iron We have no knowledge of such enduring reserves of copper ores as we have of iron On the other hand copper despite its vast importance is not the fundamental necessity that is iron It is used in less quantity in machinery and its increase in cost would less vitally affect manufacturing industries based on machinery Advancing cost would cut it out of much ornamental work of inferior esthetic merit The most serious effect would be found in raising the expenses of service in the applications of electricity Electrical transportation telegraphy and telephony would be more expensive than to-day Unless wireless methods of transmission eliminate copper or unless some discovery in the domain of physics which we do not now foresee furnishes a substitute for the omnipresent copper wire of to-day we may find ourselves face to face with some curtailment in these modern aids to the easy conduct of life s affairs If in the course of several centuries the falling off in supply and the growth in population should raise copper to relatively high figures we may wonder if a return in a way to the conditions of the Middle Ages will not result Will copper then become to a greater degree than now the basis of skilled *handiwork*? Will the bygone craftsmanship be revived and with a lessening total output shall we see an advance in artistic skill? In fact if the vast development of machinery and the huge output of metallic objects at low cost a condition so characteristic of to-day should be checked or curtailed would not hand work on more valuable mediums of expression be restored? It is not altogether unreasonable to anticipate fewer objects and higher crafts in their production

The cases of lead and zinc are even more emphatic than that of copper We have still fewer assured reserves and the pinch of increasing cost may manifest itself at an earlier date The two metals are not however quite such vital factors in modern life as is copper and the larger effects would be less apparent Zinc is a necessary component in the manufacture of brass which industry absorbs the greater part of the copper output A curtailment of either lead or zinc would cause inconvenience but would scarcely occasion fundamental changes

Silver will be very seriously affected by a decrease in the output of either copper or lead Gold will feel these changes in an appreciable but far less degree There will always be sufficient however of each of the precious metals for coinage and beyond this use their applications except perhaps in photography concern luxuries rather than fundamental necessities We can not attribute to them any profound possibilities in their influence upon civilization should the contributions of the mines decline In the recent past we have been more apprehensive regarding a too great supply of the precious metals than regarding one too small

We can perhaps justifiably forecast a future in which agriculture will figure more and more prominently and in which the moral intellectual and spiritual life of the nation will readjust itself accordingly Great and concentrated wealth is likely to be less in evidence materialistic influences less pronounced and from the vantage ground afforded by the greater comforts and opportunities of modern life as compared with that of a century or a half century past we may in the distant future look forward to an evolution upon somewhat different lines Broadly viewed the national life will probably be increasingly sympathetic with art and with ideals

Increasing Use of Bamboo

There appears to be an ever-increasing use of the bamboo in the public parks and gardens of this country, where it bids fair to become a favorite ornamental plant.

The bamboo, generally speaking, comes from the Far East, notably China, where the bamboo reed is cultivated for exportation as well as for domestic use. On its native soil it is used in different ways. Its young shoots are eaten as a vegetable its juice gives a sweet liquor like thin honey that ferments easily so that it may be used as a beverage

France carried the plant to Algeria, but the experiment was of no particular value California s great plantations are fine examples of what can be done with bamboo under favorable conditions As the great daily journals consume the forest timber the builders turn to the woods used in home building in the tropics In parks and in gardens for seaside tents and for bungalows the bamboo wood is especially adapted being light durable easy of transportation and comparatively inexpensive

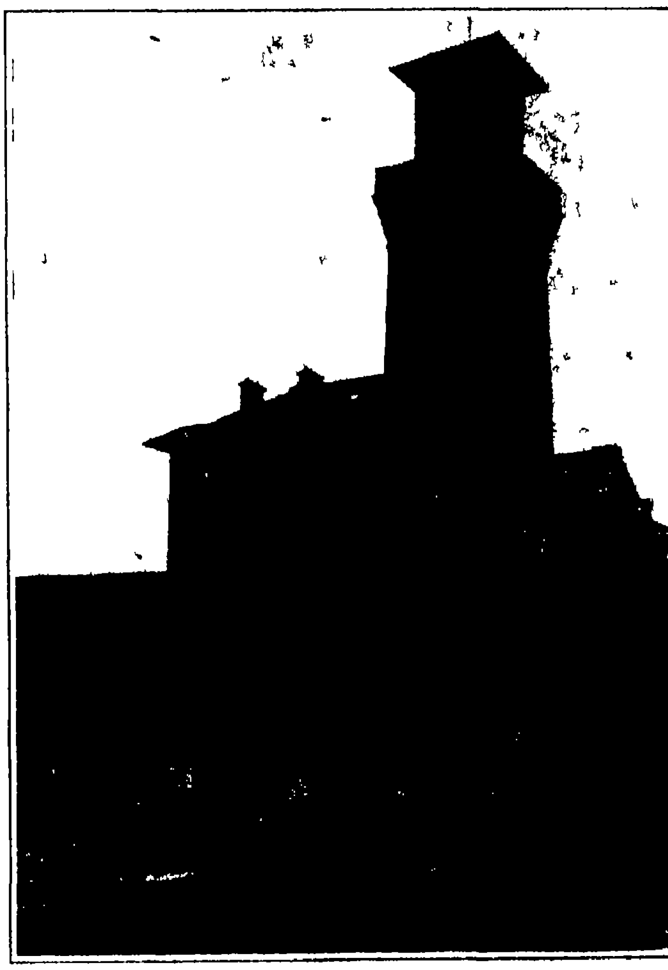
France led the way in western utilization of the bamboo but California will deserve all the praise if the bamboo supplants the high priced timber hitherto used for building houses In a climate like that of southern California bamboo reeds are ideal material

Paris Oceanographic Institute

The Prince of Monaco's Splendid Foundation

By the Paris Correspondent of the Scientific American

Oceanographic work is among the most fascinating of modern science and it may also be said to be among the most recent that is so far as it relates to exploring the deep ocean bottom. By means of new instruments which are frequently being invented we are able to bring to light many strange-shaped animals some of these having a phosphorescent glow whose very existence was unsuspected a few years ago. The Prince of Monaco gave a great impulse to deep sea sounding by building a special yacht the Princesse Alice, especially for ocean exploration and has been carrying on this work for twenty years in the Mediterranean and other waters. The very valuable results which were obtained in the first expeditions of this kind led him to found a special oceanographic building at Monaco overlooking the sea, and it contains many laboratories for use in examining all the finds which come in from the expeditions of the Princesse Alice. After this institution which we already have illustrated had been in very successful working order for some time under the active direction of Prof Berget, the Prince of Monaco conceived an idea which all scientists will consider as a most valuable and timely one that is to found an oceanographic institution which should be specially equipped for this work and which should serve as a center for European research. For many reasons he was led to found the new institute at Paris and it lies under the control of the French government. However its scope is European and even world wide as in connection with the institution there was founded a scientific committee and this includes members eminent in the scientific world and selected from all countries not forgetting America by any means.



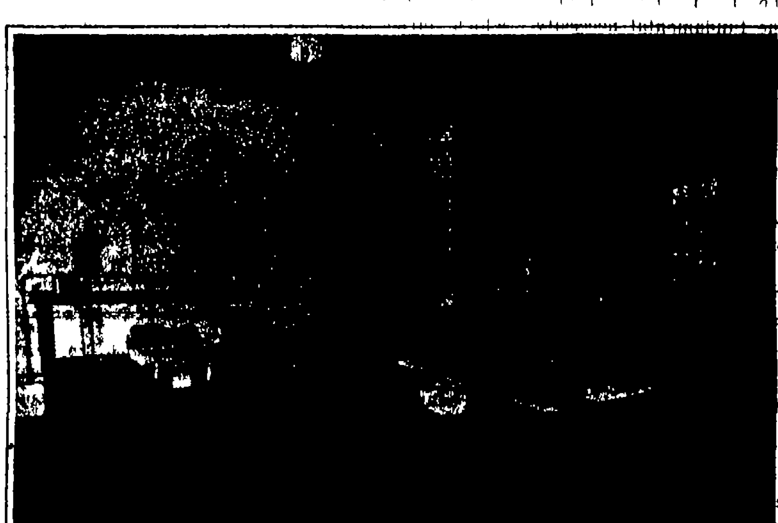
PARIS OCEANOGRAPH MUSEUM FOUNDED BY THE PRINCE OF MONACO

The Prince of Monaco endowed the institution with a fund of $800 000 in order to erect a suitable building at Paris and to carry out the needed arrangements. The object of the institution is to form a headquarters for oceanographic work which replaces the Monaco establishment although the latter is also retained for aquarium purposes and to carry on such laboratory work and examination of new specimens which must naturally be done at a point lying near the sea. The Paris institution is reserved for research and educational work in oceanographic science in the different fields of geography geology marine animal life, etc. In order to interest the public in this science there will be collections on view both at Paris and Monaco, and at Paris especially are to be organized lecture courses on the same plan as university courses or others of a more popular character, often accompanied by lantern projections. The results of oceanographic work will be embodied in different publications which will contain papers written by scientists of all parts of the world.

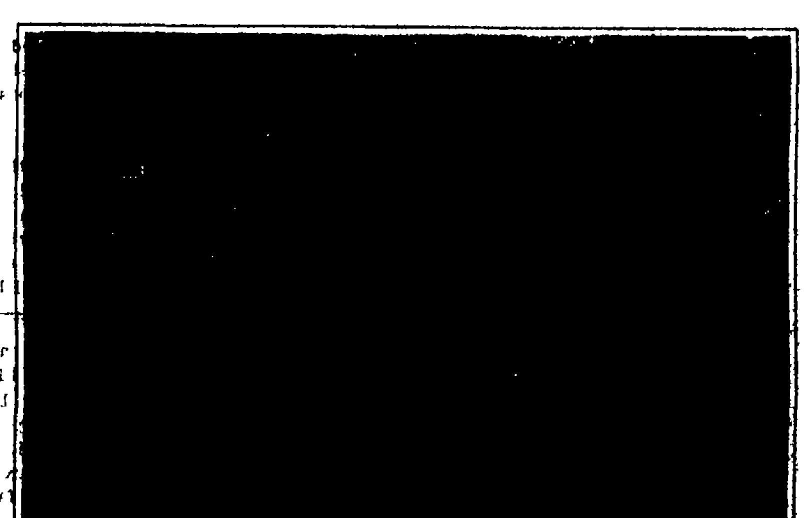
The building which our engravings represent is a handsome one and will provide roomy quarters for the laboratories and lecture halls. It lies in the University quarter of the town on the old Rue St Jacques which was one of the great Roman roads crossing the city in ancient times when Paris was scarcely more than a small island in the Seine. At present the new building is completed and the laboratories are installed so that it is soon to be in full working order. Lecture courses which are open to the public commenced in February. The building was designed by Architect Neriot and is handsomely decorated with wall paintings by prominent artists. The Prince of Monaco's address at the inauguration which took place amid a brilliant gathering representing the official and scientific world was a warm appeal in favor of oceanographic research as being especially one in which the public as well as scientists would be interested. Moving pictures were then shown on the screen and the audience followed the maneuvers of the Princesse Alice while nets or other deep sea sounding instruments were brought on board or large fish captured by lines. Other views showed some of the strange-shaped animals in their movements and the colored views of specimens taken upon autochrome photographic plates were a striking example of this new process as applied to science.

One of our views shows the main lecture hall and especially to be remarked are the very handsome wall paintings one of which represents the Prince of Monaco in the act of harpooning a porpoise. Others show the deck of the yacht when the specimens are coming in. Next to the main hall is a smaller lecture hall especially adapted for scientific courses and each hall has a well equipped projection lantern apparatus with a large screen. The building contains four stories and on the ground floor is the council room very tastefully decorated with deep sea paintings followed by the assembly room which contains a marble relief of the Prince of Monaco. The remaining floors are devoted to the laboratories. In the one which we represent herewith Prof Portier has charge of physiology of marine animals. Another laboratory is used for biology under Prof Joubin and a third for physical oceanography under Prof Berget who is at the head of the institution and is also one of the chiefs of the Monaco establishment. Collections of specimens and also of various apparatus are to be one of the features.

We should say that in connection with each of the main laboratories each professor has his own small private laboratory in which he may carry on special work while the main laboratories are open to persons who wish to enter by paying a small fee so as to follow the educational courses. However these are intended only for scientists and lie apart from the public lecture courses. In the basement a large aquarium is installed for holding live specimens and later on it will be one of the main features to be



ONE OF THE LABORATORIES OF THE PARIS OCEANOGRAPHIC INSTITUTE



MAIN HALL OF THE PARIS OCEANOGRAPHIC INSTITUTE

Here is also an electric plant and a machine where special ocean work or laboratory apparatus made.

English members are Prof Bruce of Edinburgh Prof Buchanan of Cambridge University also Sir John Murray of the 'Challenger' expeditions We note also the name of M Nansen the well known Arctic explorer Among the French members besides those already mentioned are Prince Roland Bonaparte Dr Richard the head of the Monaco establishment and M Yves Delage Germany is represented by Drs. von Drygalski of Berlin M Hergesell of Strasburg Drs Chun and Hensen and others, and in all there are thirty members and many countries thus aid in the success of the enterprise

Steel Cars for Passenger Trains

Designed and Built by the Pennsylvania Railroad Company

The Pennsylvania Railroad has in service 764 all steel cars of various types and 358 cars now under construction The company has gone further in the direction of the use of steel cars than most other roads The Pennsylvania's policy in this respect was the result of a long period of inquiry and experiment in which the late President Cassatt took an active part After several cars had been built the president appointed a committee of motive power officials to make a thorough report on the designs to be adopted and the cars are now being built in accordance with the recommendations of that committee

WOODEN CARS DO NOT MEET MODERN REQUIREMENTS

The demand for passenger cars which would be stronger and better able to meet the severe conditions of service led to the consideration of other materials than wood for their construction Growing scarcity of suitable timber and its rapidly increasing price played an important part in the development since wood cars would soon cost as much as those of non combustible materials

TYPES OF CARS

After carefully considering the problem from all sides the Pennsylvania Railroad Company decided to adopt two types of steel passenger equipment

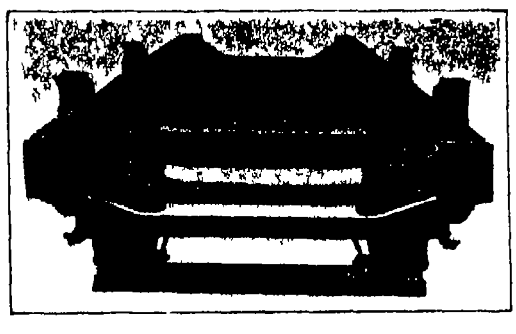
(A) For through trains drawn by steam or electric locomotives and composed of mail baggage sleeping dining or day coaches A long car of heavy construction suited to withstand the strain incident to pulling coupling or buffing in long trains

(B) For suburban trains drawn by a locomotive or propelled by motors upon the truck axles a short car of lighter construction well suited to operation in frequent short trains to accommodate the traffic

REQUIRED STRENGTH OF FRAMES

In preparing the designs for heavy type equipment great care has been exercised to provide ample strength to resist end shock of buffing or collision Standard steel freight cars are designed to resist an end shock equivalent to 400 000 pounds compression Experience with freight cars during the last five years indicated that this is not excessively high An experimental determination of this figure was made by allowing a dynamometer car weighing 51 000 pounds to bump a number of loaded freight cars standing upon the track The dynamometer registered 607 000 pounds Another experiment was made by allowing a loaded steel freight car and the dynamometer car weighing together 181 400 pounds to bump a loaded freight car standing on the track

normal loads due to the weight of the car and lading Under these conditions the combined fiber stress is limited to 12 500 pounds per square inch for cars in through train service and 20 000 pounds per square inch for cars in suburban service In determining these stresses none of the material above the belt rail is included excepting in the case of the horse-express car and the car designed for the Newark Rapid Transit Service which have sufficient reinforcement above



THE NEW TYPE OF SIX WHEELED TRUCK

the doors to take care of the various strains In the rest of the cars the sides beneath the window sills form girders about three feet deep for which the belt rail acts as the top flange and the outside sill as the bottom flange Owing to their great length the thinness of the web and the comparative shallowness of the flanges these girders would probably collapse if subjected to end thrust In calculations therefore the web and upper flange are not considered as resisting any of the 400 000 pounds load assumed to represent the effect of buffing

The superstructure of cars is made strong enough so that they can roll completely over without danger of collapse Posts car lines and other parts are proportioned under this assumption

The ends of cars are framed in such a manner as to resist end shock Deck or I beams forming the frame about the end door and securely fastened to both end frame and roof are proportioned with this idea in view These features are shown in one of the accompanying illustrations

TYPES OF FRAME CONSTRUCTION

In the design of framing for steel cars two general types have been developed One in which the center type is usually rather light being designed to resist the end loads developed by ordinary pulling and light buffing This type of framing follows the general form used in wooden cars where the transverse loads are carried by wooden trusses within the sides of the car reinforced by truss rods beneath the side sills

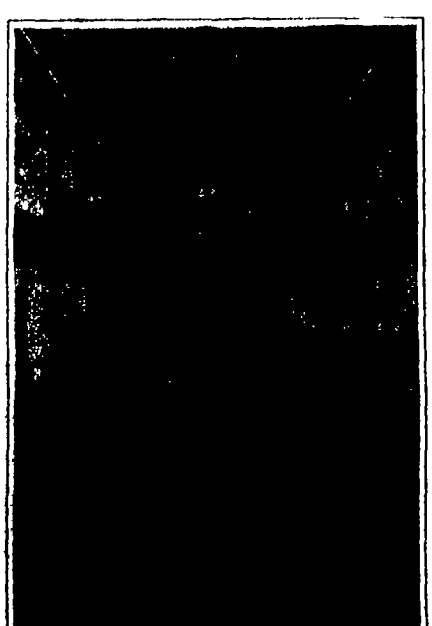
For through train service subjected to heavy buffing and pulling the center sill type of frame has been selected It has also been used in designs for suburban type equipment as it has been found that with a modified form of center sill sufficient room for motors was provided between the underframe and track

DESIGN OF CENTER SILL

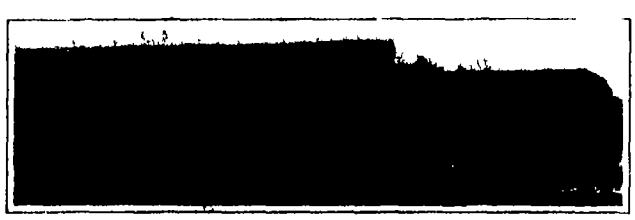
The height from the track to the center of coupler is determined by law and the height to the top of the floor is practically regulated by custom The center of the draw bar is therefore fixed at about 17 inches below the floor

In wooden car construction the center sills are usually rather shallow and the coupler is supported below them Loads upon the underframe brought about by buffing tend to bend down the ends of the car due to the fact that the center sills are not symmetrically loaded In the steel car of the through train type the center sill is made deep enough to bring the line of coupler within its section

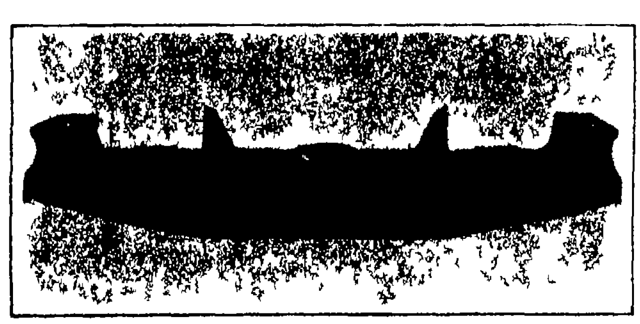
With the heavy center sill frame body bolsters as used in wooden car construction are unnecessary for the major part of the transverse load is delivered directly to the center sill which transmits it to the trucks through center plates carried on its under surface The transverse loads which come upon the sides of the car and which must be transferred to the center girder are delivered at four points to equalize the loading The center sill is a continuous girder supported at two points by truck center plates and loaded with a practically uniform longitudinal load which it carries directly together with four transverse loads delivered to it from the sides of the car through cross bearers and body ends The points of application of the concentrated loads are so selected that the two loads at each end are about equidistant from the center plate Under this condition it has been possible to obtain in the center sill practically equal fiber stress at the middle and over the center plates thereby securing great economy in the metal and avoiding the use of a center sill of deeper cross section at the middle than over the trucks With the comparatively thin sheet steel metal used in sheathing the sides and roof it is of great importance to avoid unnecessary



INTERIOR OF THE STEEL MAIL CAR



GENERAL VIEW OF THE STEEL CAR SUPPORTED ON TWO SIX WHEEL TRUCKS



STEEL BOLSTER OF THE TRUCK

INTERIOR OF THE PASSENGER CAR

The dynamometer recorded 400 000 pounds In a collision between passenger and freight cars it is desirable that the passenger car should be the stronger in order to escape with as little injury as possible.

In computing loads upon the various members of the frame it has been decided that a compression load of 350 000 pounds between buffers, also 150 000 pounds between draft gear is to be added to the sill is made strong enough to resist the end loads developed by pulling and buffing in addition to the transverse loads due to the weight of under frame superstructure and lading The other type in which the plate girders formed by the sides of the car beneath the windows are relied upon to carry the transverse load due to the weight of the under frame, superstructure and lading The center sill in the latter loading as it is likely to cause loosening of the joints and working of the rivets in their holes With this form of construction the side girders are made comparatively light as they sustain little transverse load and are supported at four points Side doors required by mail express, or baggage cars can be located where most convenient without requiring any material strengthening in the side truss

The following table gives the comparative strength and weight of steel and wooden cars

	Standard Wooden Passenger Coach 58 Feet Long	Heavy Type Steel Passenger Coach 70 Feet Long	Suburban Steel Passenger Coach 54 Feet Long
Number of passengers	68	88	72
Car weight pounds	91,000	116,000	86,000
Car weight per passenger pound	1340	1307	1071
Area center sill at middle of car, square inches	152	50	24 22
Area center sill at center plate of car square inches	109	50	33 88
Stress in center sill due to 150,000 pounds buffing and 1,000,000 pounds draft gear and ... per square inch	10,850	11,000	18,500
Comparative strength of center sills	25	18	60

HEAVY TYPE 70-FOOT STEEL PASSENGER COACH

In general arrangement and appearance this car is almost an exact copy of the standard wooden passenger coach

Two 18 inch by 44 2 pound channels with ½ inch × 24 inch cover plates top and bottom form the center sill Cast steel center plates are riveted to the under side of the sill which is reinforced at these points by steel castings riveted inside Projecting beyond each end of the center sill are steel castings designed to transmit directly to the center sill the loads due to buffing and to support the spring rods carrying the vestibule buffer plates

These castings are provided for the introduction of the vertical channels forming vestibule posts Within the center sill near each end are riveted steel castings arranged to carry the couplers and draft gears

The side sills are of 5 inch × 3½ inch × 9/16 inch angles Each sill is supported at its end by end sills and at two intermediate points about 14 feet from each end by cross bearers

The end sills are of the cantilever form riveted to the center girder and built up of angles the outside sheathing plate acting as the web

The cross bearers also of the cantilever form and each composed of two triangular plates flanged about the edges are riveted at their base to the center sills Opposite cross bearers are joined by cover plates which pass over the top and under the bottom of the center sill

Each side sill is held in line by nine struts of 5 inch channels connected to the center sill These struts do not transmit any vertical load from the side sills to the center sill

Cast steel side bearings for engaging the trucks are secured to the side sill in line with the center plates

Pressed steel posts spaced 5 feet 11 inches centers support the superstructure They are of channel section and the edges are flanged out and riveted to the inside sheathing forming a box section Their lower ends are securely riveted to the outside sills and their upper ends are tapered down and bent inward forming lower deck carlines At their upper ends these posts are riveted to the plate carrying the deck sash The lower edge of this plate is bent out beneath the ends of the posts and forms a continuous beam of angle section running the entire length of the superstructure

Between the main posts are shorter intermediate posts which extend only from the window sill to the plate carrying the deck sash They are of light channel section with edges flanged for riveting to the outside sheathing forming thereby a box section

Upper deck carlines are of sheet steel pressed to channel section with edges flanged out for riveting to the 3/32 inch steel roof plate The ends of the car lines are riveted to the plate carrying the deck sash The upper edge of this plate is bent outward and down forming a continuous beam of channel section to which the edge of the roof plate is riveted Malleable iron braces unite the ends of each post and its corresponding carline

The outside sheathing is of ⅛ inch steel and the course below the belt rail is riveted to the outside sill and vertically to each post.

The steel shape forming the under sill for the windows laps over the side sheathing and rivets passing through the belt rail which runs the entire length of the car secure this joint The outside sheathing above the windows is riveted vertically to the posts and its upper edge is riveted to a channel shaped steel section forming the eaves for the lower deck and extending the entire length of the superstructure

The inside lining including ceilings and bulkheads is of 1/16 inch steel to the unexposed face of which 3/16 inch asbestos is cemented Molding closely resembling that used in wooden construction is pressed and drawn from steel and its use adds greatly to the artistic appearance of the interior

The window sashes are of wood and slide in a formed steel frame Malleable castings riveted to the posts support the window frames The window stops, which also form ways for the curtains, are of extruded bronze The deck sashes are of malleable iron

The floor is formed by corrugated or keystone steel plates which are supported by the center sill and upon longitudinal angles secured to the side posts. These plates are covered to a maximum depth of 1½ inches with a plastic surface filling, composed largely of cement.

A sub-floor of asbestos ⅜ inch thick supported by No 20 galvanized sheet steel is secured to the center and outside sills.

Along each side of the car just above the floor rectangular ventilating ducts are provided which inclose the heating pipes and discharge warm fresh air into the car

In the construction of the platform and vestibule an effort has been made to secure sufficient strength in the end of the car to prevent the superstructure from being swept off from the underframe by the next car in the event of a collision The center sill is the main support of the entire vestibule and to it are securely framed the 9 inch bulb angles forming the end door frame together with the 9 inch channels forming the vestibule posts These vertical members are relied upon to prevent damage to the superstructure during collision

The vestibule floor plate the end sills and sheathing and the vertical bulb angles are securely framed together to give an exceptionally strong foundation for the end construction

The end of the vestibule is supported by two outside posts of pressed sheet steel together with two channel posts forming a doorway The base is formed by a pressed steel platform end sill and the top support is given by the vestibule ceiling plate

SUBURBAN TYPE—54 FOOT STEEL PASSENGER COACH

The general arrangement and appearance of this car are similar to the heavy type equipment but the car is lower shorter and the space allowed each passenger is less than in the larger cars The arrangement of seats has been modified to suit the traffic

The underframe construction closely resembles the heavy type car but in order to provide sufficient space for motors the center sill is made more shallow It is formed by two 9 inch channels with a single ¼ inch cover plate on top and two ⅝ inch cover plates upon the bottom This form of section keeps the center of gravity low and decreases the bending movement brought about by the fact that the drawbar is below the center sill entirely The center plate is of special form adapted to reach the same trucks on heavy type equipment and the casting in closing the coupler and draft gear is attached to the under side of the center sill instead of being placed within it as in the case of the heavy type car

The framing of the body is similar to that used in the heavy type coach the main posts being identical except in the matter of length and shape at the top There are three windows between main posts instead of two as in the heavy type coach

STEEL SLEEPING CAR

In order to complete the equipment of steel cars for passenger trains the Pennsylvania Railroad Company has arranged with the Pullman Company to design and build some all-steel parlor and sleeping cars of which 638 are now in service

In both exterior and interior appearance they closely resemble the standard wooden Pullman car except in the interior finish where steel replaces the highly polished natural wood

Steel is used for inside finish and is backed by asbestos to act as a non-conductor of sound and heat except in cases such as the back wall of upper berth the berth partitions and possibly a few other cases where non inflammable composition material is used as the steel is too cold to the touch

The trucks are of standard Pullman type supplied with cast steel frames in place of the usual wooden members

The principal dimensions of the cars are

	Feet	Inches
Length over end sills	72	6
Length over platforms coupled	80	6
Width over side sills	9	9¼
Width over eaves	10	0
Height over all	14	7

THE SIX WHEEL TRUCK

An entirely new form of truck was required for the steel cars owing to the fact that the deep center sill of the underframe lowered the center plate until it just cleared the middle axle of a six wheel truck Advantage was taken of the opportunity offered for re-design and a truck based upon a new principle was evolved which is applicable either to four wheel trucks for motor cars or four and six wheel trucks for those drawn by locomotives The new truck utilizes to the best advantage the valuable properties of steel as a structural material, is designed to carry a load equivalent to the maximum capacity of the ... inch axle, weighs 21,000 pounds (which is the same as the weight of the old wooden trucks), but is considerably stronger Transoms, spring planks and equalizers, though important parts in former truck designs, are not required, as their functions are performed by other elements in the new principle of design

The accompanying illustration, page 377, shows the exterior appearance as well as the construction of the truck Two elementr are embodied, the rectangular frame carrying the vheels, and the bolster which transmits the load delivered at the center plate to the axle through the spring rigging

The axles run in boxes of the usual type which slide vertically in pedestals, secured to the wheel pieces and connected at their bottom ends by pairs of tie bars (sufficient space being allowed between the bars to permit the use of a jack in removing bearings) Each wheel piece is composed of two 10-inch channels (with their flanges turned toward each other) separated to permit certain of the working parts to go between them and secured to one another at intervals

Two wheel pieces are held together by four pressed steel cross members of channel section, one at each end of the wheel pieces and one at either side of the middle wheels. They are depressed below the bottom of the wheel pieces in order to clear the center sill of the underframe

The bolster is composed of four girders running crosswise of the truck to the top of which are secured two girders running lengthwise of the truck The center plate rests upon two short transverse girders of pressed steel The lower flange of these girders is turned up at the ends and the plate riveted to the lower flange is brought up and riveted to the longitudinal girders Between the transverse girders is riveted a reinforcing casting to transmit the load delivered by the center plate A horizontal rectangular plate forms the lower flange of both longitudinal girders and acts as a diaphragm to square the bolster Spring beams are riveted to the under side of the longitudinal girders and to the rectangular plate which forms their lower flanges They extend on both sides beneath the wheel pieces and are confined between guides which allow only vertical and transverse motion of the bolster with reference to the truck frame The spring beams are of sufficient width to admit between their downwardly projecting legs four elliptical springs

The entire load borne by the truck is delivered by its bolster to sixteen elliptical springs which rest upon equalizers having a ratio of 2 to 1

The equalizers are suspended from hangers which deliver to each box of the middle axle one-sixth and to each wheel piece one third of the entire load borne by the truck This load is delivered to the wheel piece at two points near the outside pedestals so that each box of the outside axle received one-sixth of the entire load borne by the truck Each box receives its load through a nest of three helical springs which in the case of the end axle bear upon castings secured to the wheel pieces and in the case of the middle axle bear upon short equalizers connected to the hangers The boxes of the middle axle therefore move up and down freely and without any connection or relation to the wheel pieces

Side motion of the bolster relative to the wheel pieces provided by the hangers and guides is limited by abutments secured to the spring beam Helical springs resting upon followers guided by the wheel pieces and engaging the abutments centralize the bolster and give easy riding qualities equal to those secured by the link suspension generally used on wooden trucks.

The outer abutments also act as side bearings for the car body and engage castings secured to the outside sills

COUPLER AND DRAW BAR.

It was found upon careful investigation that the standard form of draw-bar and coupler heretofore used on wooden cars did not allow sufficient side motion of the coupler head in rounding curves The resultant binding was particularly noticeable upon long cars, and to remedy the defect an entirely new arrangement was devised by means of which a lateral motion of about 8 inches each side of the center was secured

Owing to the large amount of side motion, coupler heads would interfere with steam and air pipe valves in their regular position. Projecting arms are provided on each side of the center sill at end of car for supporting these pipes, allowing them to move to clear the coupler on curves.

FOUR-WHEEL TRUCK FOR SUBURBAN TYPE COACHES.

Designs for a new type of truck for suburban service have been completed and trucks are now being built accordingly. This design is arranged in such a

manner that the same frame, bolster and detail construction may be used for either the motor or trailer truck.

The frame consists of two side frames which are composed of 8-inch Bethlehem H beams equipped with cast steel pedestals at each end. A transom is rigidly attached to the side frames by means of corner gussets and a bolster is placed inside of the transom supported on quintuple elliptic springs carried by spring carrier bars flexibly attached to the side frames. The transom corner gussets include the brake hanger fulcrums. The transom is made of pressed steel channel shaped so as to permit the placing of the bolster between the vertical legs of the transom.

Stalactites

How they are Formed in the Laboratory and in Nature

By George H. Martin, M.A., F.C.S.

It is a matter of common experience in everyday life, says *Knowledge*, that when an article appears to be hopelessly lost, it is often found again in the process of looking for something else. So also in the domain of science when experiment after experiment has failed in the search for the constitution of a compound for a method of preparing some substance on an advantageous commercial basis or what not, the clue to the problem is frequently found in the course of an entirely different investigation.

In the case in point, for example, attempts were being made in connection with a course of lessons in elementary geology to prepare stalactites in the laboratory. The process seemed simple enough; all that was necessary theoretically was to allow a solution of bicarbonate of calcium to drop slowly from a small aperture and patiently to await results. Nothing, however, happened although the experiment was tried in several ways. About the same time for a different purpose a burette full of lime-water was so arranged that the lime-water dropped from it with extreme slowness. This experiment also failed, but for some reason the apparatus was not dismantled and the burette was left for some weeks with the lime water still dropping slowly. When, however, the burette was again examined it was noticed that a slight deposit was forming around the aperture of the nozzle, and it seemed just possible that if the process were allowed to continue a stalactite growth might form at the end of the burette.

And so it proved—a strange result when one considers that of the two experiments, one of which was started in the hope of making a stalactite, this was the one that was not begun for that purpose.

The growth of the stalactite was watched with much interest and it proceeded with comparative rapidity. At the end of six months it had reached a length of one inch and a half, which means a growth at the rate of 1/150 inch per day. The stalactite grew in the form of a hollow tube, not quite straight but gently waved (see Fig. 1), and of approximately the same diameter throughout its length. The growing end of the tube was fringed with tiny fern-like projections which clasped the pendant drop as a jewel is grasped by its setting. Through a microscope it presented a beautiful appearance.

The projections were then seen to be fronds of crystalline growth—wonderfully fern-like in appearance and sharp in outline (see Fig. 2). The drops which at the beginning of the experiment soon became milky afterward remained perfectly clear the whole time they were forming; no separation of opaque calcium carbonate appeared to take place.

At the end of six months it was desired to show the stalactite at the annual meeting of the Public Schools Science Masters Association (January 1910), so the experiment was stopped and the burette was emptied and carefully laid on its side. Then with the point of a knife the stalactite was detached from the burette with the utmost care and successfully introduced into a glass tube on a cushion of cotton wool, where it still remains. In appearance it is a delicate cream-colored tube of interwoven silky crystals, its whole weight being only one-fifth of a gramme.

The drops of lime water had fallen from the burette at intervals of about three and a half hours, making a total of eight drops, that is about three-quarters of a cubic centimeter (0.046 cubic inch) per day. The drops fell upon a watch glass where they evaporated to dryness, leaving a slight and apparently amorphous deposit.

It is interesting to compare the weight of the stalactite given above with the maximum weight of calcium carbonate theoretically obtainable from the amount of lime water used. Three-quarters of a cubic centimeter a day mean about 137 cubic centimeters (8.36 cubic inches) in six months (the burette was replenished as required from time to time), and since the solubility of calcium hydroxide in water at the ordinary temperature of a room is 0.14, the above volume of water will dissolve 0.19 gramme of calcium hydroxide at that temperature if a saturated solution is formed; and 0.19 gramme of calcium hydroxide ... 0.144 gramme of calcium oxide, which is equivalent to 0.257 gramme of calcium carbonate. The stalactite itself weighs 0.2 gramme, the difference being due partly to the fact that some of the stalactite remained adhering to the burette and partly to the fact that some of the lime remained in the drop as it fell, and further the lime water in the burette, even

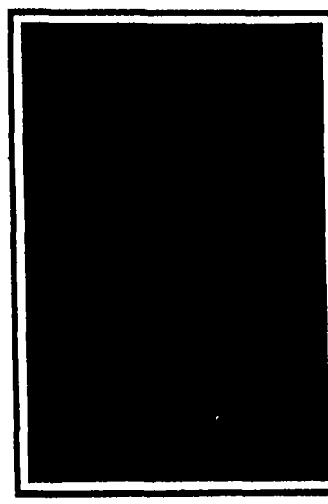


Fig. 1

A Stalactite Forming on a Burette From Which Lime Water is Slowly Dripping

if fully saturated at the start, did not remain so, but there was always a certain amount of amorphous calcium carbonate precipitated from the solution, as may be seen at the bottom of the burette in the first photograph. The volume of carbonic acid gas required to form the calcium carbonate of which the stalactite is composed would be contained in about one hundred and thirty-three liters (35.13 gallons) of ordinary air. It might be noted here that the stalactite grew in a room which was only occasionally used, and for only short periods, so that the percentage of carbonate acid gas in the air would correspond pretty closely with the normal value.

So much for the facts; how do they compare with the generally accepted theory of the formation of stalactites, viz., that they are invariably produced by *the deposition of calcium carbonate from a solution of* bicarbonate of calcium? Here we have an obviously stalactitic growth formed by the dropping of a solution not of bicarbonate of calcium but by one of lime, so that an alternative method of formation seems possible. Do the conditions necessary for this alternative method ever obtain naturally? Is lime water ever dropping through the air in conditions similar to those in which it drops from the burette in the above experiment?

Fig. 2

One of the Crystalline Projections Which Clasp the Drop Shown in Fig. 1 as Seen Under the Microscope

The answer to these questions is apparently yes. It has been tacitly assumed by geological writers that the stalactitic deposits formed under railways and other arches are produced in precisely the same manner as the stalactites and stalagmites of a limestone cavern. But is this so, at any rate in the earlier stages?

Is it possible for the whole of the lime—that is, for one-third or one-fourth of the whole bulk of the mortar contained in the two to three feet in thickness of brick or stone work which usually compose the masonry of a newly built railway arch—to be changed into carbonate of lime by the time that the first signs of stalactitic growth appear? Apparently not, for according to Mr. Dibdin in his Lime Mortar and Cement, the absorption of atmospheric carbonic acid gas by mortar, although at first rapid, gets gradually slower. Mortars even centuries old are said to still contain appreciable quantities of hydrate of lime. This being so, it seems incredible that there could be any free carbonic acid gas available for dissolving calcium carbonate, at any rate in mortar under ordinary conditions, although it may be possible for the mortar in damp railway arches through which rain water is constantly passing to become saturated with the gas more rapidly. However this may be, the fact remains that this complete transformation is not necessary; stalactites of carbonate of calcium can be formed from lime water in contact with the carbonic acid gas of the air, and the general similarity in appearance between the stalactites of such bridges, hollow fragile tubes of approximately even diameter, and the artificially formed stalactite described above points to the conclusion that these stalactites and those of limestone caverns are due, at any rate in their initial stages, to quite different causes. In the case of the railway and other arches the rain water *percolating through the mortar must dissolve some of* the lime, the carbonic acid gas in the rain water combining at the same time with another small portion of lime, thus rendering it insoluble in the water which has *already lost its carbonic acid gas*, so that the drops issuing from the under surface of the arch must consist practically of lime water. As shown above, lime water will form stalactites when allowed to drop slowly, so that stalactitic growth may start very shortly after the brick work has been put into position—as soon, that is, as the mortar in it becomes saturated with rain water.

That the explanation given above is the true one is supported by the marked difference in the method of growth of the two kinds of stalactites, viz., those formed from bicarbonate of lime and those formed from lime water. Sir Archibald Geikie, on page 475 of volume 1 of the new edition of his Text Book of Geology, says in connection with chemical deposits: "Of these by far the most abundant is calcium carbonate. The way in which this substance is removed and re-deposited by permeating water can be instinctively studied in the formation of the familiar *stalactites* and *stalagmites* beneath damp arches and in lime-stone caves. As each drop gathers on the roof and begins to evaporate and lose carbonic acid, the excess of carbonate which it can no longer retain is deposited round its edges as a ring. Drop succeeding drop, the original ring grows into a long pendant tube, which by subsequent deposit inside and outside becomes a solid stalk, and on reaching the floor may thicken into a massive pillar. At first the calcareous substance is soft and when dry pulverulent, but by prolonged saturation and the internal deposit of calcite it becomes by degrees crystalline."

It is here clearly stated that the original deposit which goes to form a stalactite (whether in a limestone cave or under a damp arch) is soft and that it only becomes crystalline by degrees, whereas the stalactite formed from lime water grows by a *method of crystallization*, as may easily be seen in Fig. 2, which is a microphotograph of the growing point of the tube, in which the magnification is about thirty-eight diameters. It somewhat resembles, except in rate of formation, a frond of crystalline salammoniac as seen growing on a glass slide under a microscope, and it is in striking contrast with the soft amorphous deposit of calcium carbonate one so often sees in lime water. Again, the deposition of the calcium carbonate which goes to form a stalactite, as stated in the above extract, is due to loss of carbonic acid gas, and takes place at the base of the drop,

but as may be seen on an examination of the drop in Fig 1 the claws of the crystalline growth nearly encircle the drop and it appears almost as if the extension of this crystalline growth was due to and coincident with the absorption of the carbonic acid gas of the air by the lime water a suggestion which is supported by the fact that the drop of lime water remains absolutely clear and bright through all the stages of its formation, none of the milkiness usually caused by prolonged exposure to the air being apparent

It would be strange indeed if the causes of formation of the two kinds of stalactites should be of such an opposite nature viz In one case the loss, and in the other the absorption of the carbonic acid gas of the atmosphere, but one seems forced to that conclusion unless, as is just possible, both processes take place in the case of the drop of lime water, the gas being absorbed in the earlier stages of its formation and lost in the later stages as the water in the drop evaporates but if this explanation were the true one, the drop would be milky in the earlier stages of the growth whereas, as already stated, this does not appear to be the case

The "Olympic" and the "Titanic"*

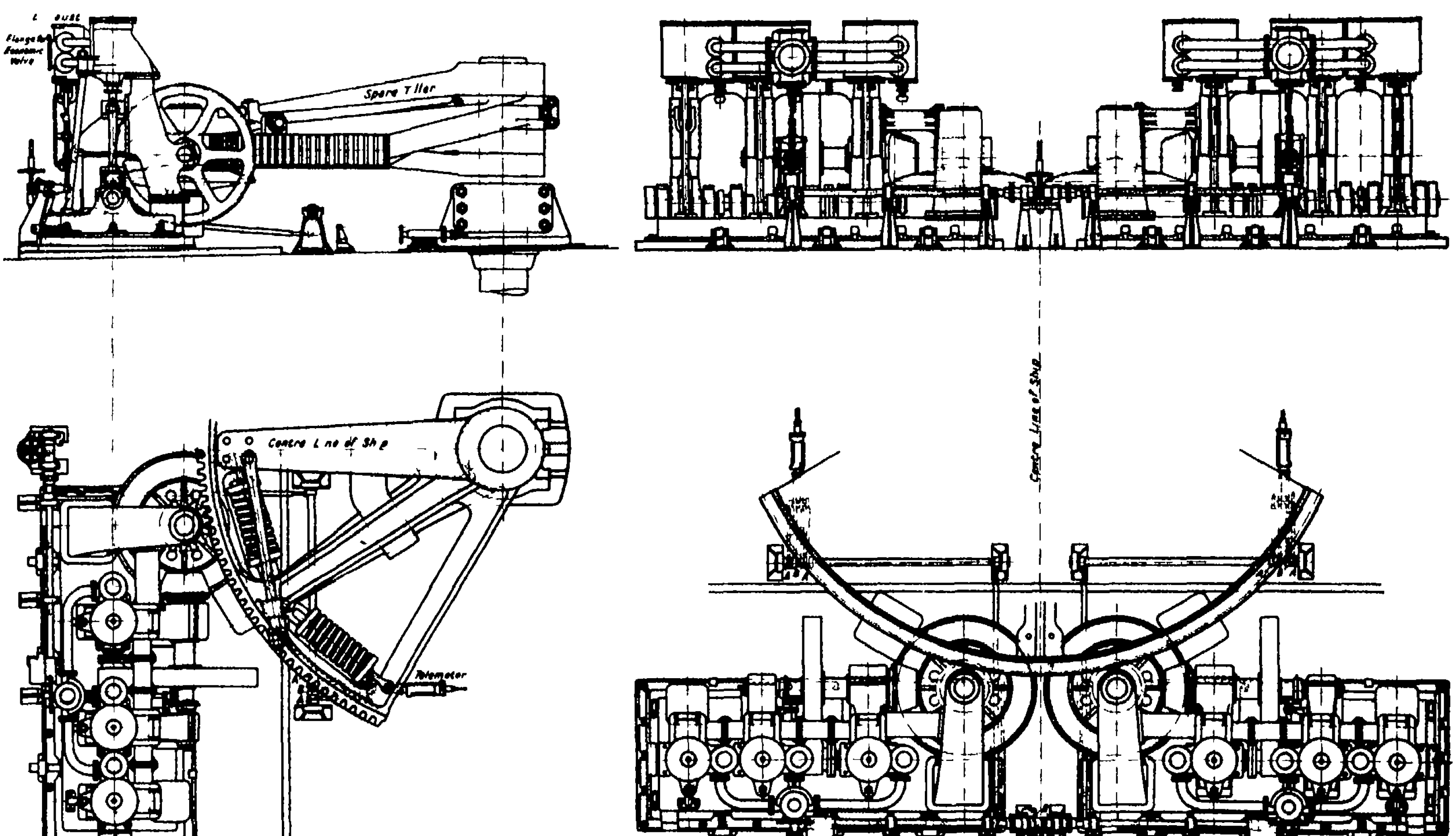
Two Giant Ocean Steamships

Thanks to the courtesy of the owners and of the builders Messrs Harland and Wolff we have been permitted to make a thorough inspection of the whole of the Olympic and her machinery as she now lies afloat off the fitting out quay situated some distance farther down Belfast Lough than the yard from which she was launched Here she lies with a huge 200 ton floating crane alongside and with her forward launching cradle still attached till she can be placed in the big graving dock 886 feet long by 96 feet wide at the entrance which is now under construction specially for her and her sister by the Belfast Harbor Commissioners Drawing as she does some 14 feet less than she will do when fully loaded and equipped her great height above the water does not permit her real size to be appreciated though there is no doubt that she is very well named Indeed on expressing worthiness only those who have had experience of the comparative behavior of the big and little ships in a heavy head sea can appreciate Another rather striking feature which is clearly brought out by the diagram is the comparatively insignificant increase in the amount of draught from the early boat amounting to only 30 per cent though the length is nearly doubled Draught is of course likely to have a restraining influence on any further great increases in size for some little time to come as its increase would entail very heavy expenditure in further dredging operations The actual dimensions of the two new boats are

Length over all	882 feet 6 inches
Beam	92 feet 9 inches
Depth	97 feet 4 inches*

* Bottom of keel to boat deck

accessible for marking off with the sheer strake A more fitting occasion on which to give details of the passenger accommodation will arise later on but it may be of interest to mention here that in addition to luxurious suites of rooms there will be a swimming bath 33 feet by 14 feet with a depth of water of about 9 feet a squash rackets court 16 feet 6 inches high electric passenger elevators etc The ventilation too will be carried out on a very elaborate scale with a view to insuring perfect comfort and health below even though the weather is so bad that ports cannot be opened or the passengers allowed on deck for fresh air and exercise The heating will be designed as far as possible to suit the comfort of chilly passengers or the reverse air is drawn by means of a number of electrically driven Sirocco fans through steam radiators and delivered at a temperature of



STEAM STEERING GEAR OF THE WHITE STAR LINER "OLYMPIC"

our wonder that two such typically White Star names as Olympic and Titanic had not been pressed into the service before we learned that they had been specially saved up for some really worthy representatives of this mammoth fleet which now amounts to 418 000 tons We are almost tempted to express further wonder why this should be considered the critical moment for the bringing forth of these hoarded treasures in the way of nomenclature and to ask what will happen when judging from past history the inevitable 1 000-footer comes along—and surely even then we shall not have the R M S Finalic ? It seems but yesterday that the names Britannic and Germanic were mentioned almost with awe as being the last word in steamship construction—certainly well within the memory of a generation and yet our diagrammatic sketch showing one of these boats together with the Teutonic launched some fifteen years later compared with the Olympic shows that these wonderful old ships have been left far behind in point of size One of the most striking of these elements of size is, we think, that of freeboard forward which in the case of the Olympic is considerably more than double that of the 'Germanic" and what this means in comfort and sea

* *The Engineer*

Added to the above the following statistics may be of interest Height of funnels above casings 62 feet keel to top of funnels 165 feet launching weight about 26 000 tons gross tonnage 45 000 displacement, 52 000 tons draught 34 feet 6 inches shell plates (largest) 36 feet long and 1¼ inches thick, number of decks 11, number of water tight bulkheads 15, capacity of double bottom 5 700 tons cargo capacity 5 600 tons, number of passengers provided for 2 500, crew 850 while over 2 000 sidelights are fitted in the ship and 16 boats are carried It may further be noted that the smallest steamship ever built by Messrs Harland and Wolff—71 feet in length—could easily be accommodated on the poop deck of the Olympic

Naturally the designing and building of such a ship has called for many special appliances such as the 200-ton floating crane mentioned above. This crane can lift a weight of 150 tons to a height of 149 feet at a radius of 100 feet with a list of only 4 degrees while the small hook can lift 50 tons at a radius of 140 feet. While in the drawing office we noticed that the ¼ inch to the foot half-breadth model used for measuring off the plating plant was carried on a special worm and wheel elevating gear to enable the garboard and bilge strakes to be equally

about 60 degrees through trunks to all the saloons state rooms etc those who desire greater heat will find electric heaters in their cabins, by which they can roast themselves to their hearts content. All the lavatories galleys, etc, are however ventilated by means of suction fans of slightly greater capacity than the pressure fans so that the air below is always kept sweet and fresh The water closets and lavatories are arranged toward the center line of the ship, which, though complicating the pipe arrangement, allows of a greater number of outside cabins than on the usual plan. Throughout the passenger accommodation the steel deck plates which are joggled, are covered with Lito-silo a composition accepted by the Board of Trade which is fireproof, pleasant to walk on and not slippery or noisy, while nails or screws can be equally well driven into it.

There are of course a great number of other matters of interest from a shipbuilding point of view, but we propose to confine ourselves henceforward to a description of the purely engineering features of the ship, these in themselves, as is to be expected, would demand a great deal more space than we can afford if we were to attempt to deal with them all in full detail, so that we shall endeavor to give a fairly complete and general description, and where possible dis-

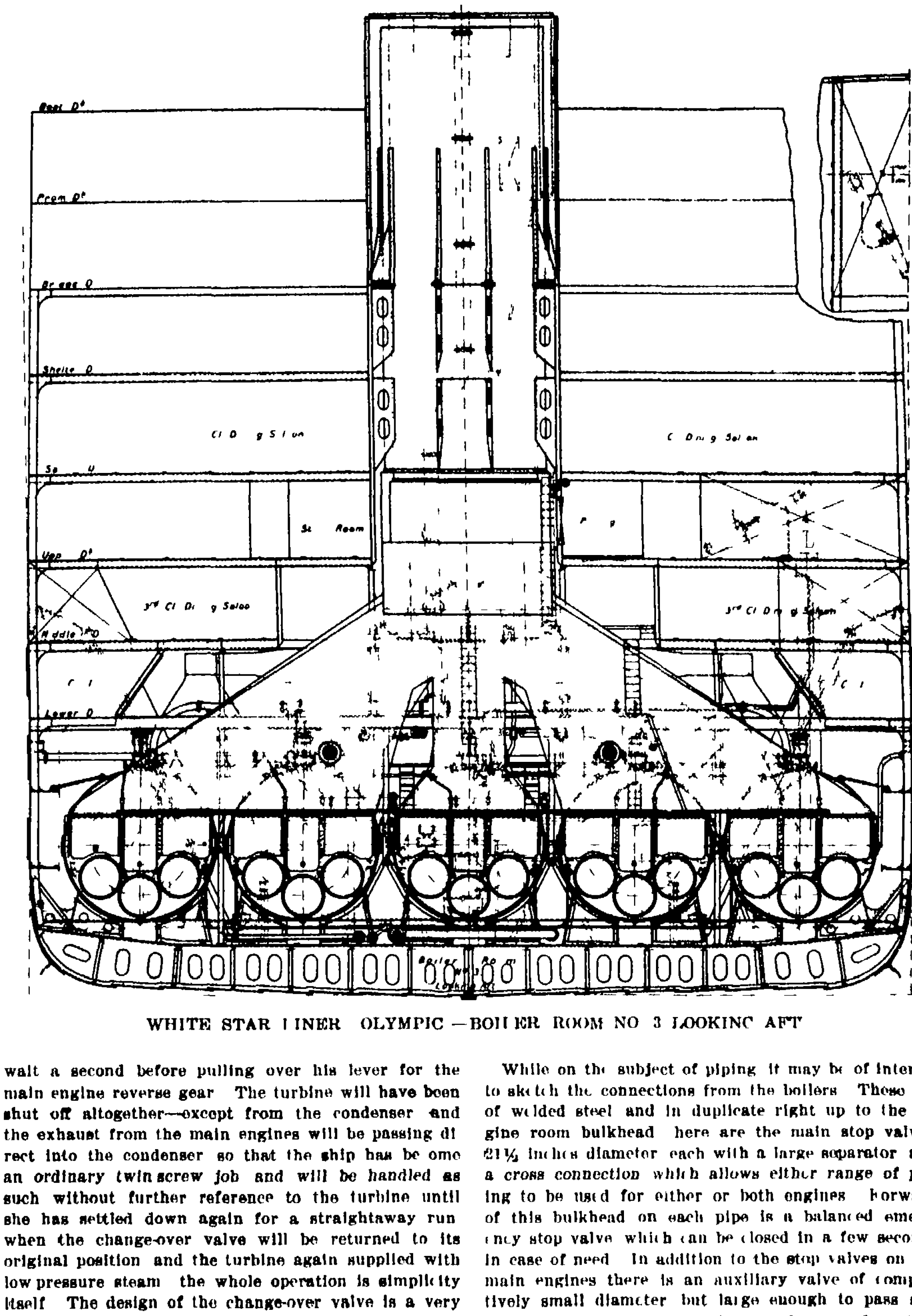
... the most interesting features and not go into figures to any very great extent. By so doing we shall hope to avoid any resemblance to a mere catalogue of particulars, and so present our facts that they shall be of such general interest as befits a record of what may almost be called a national possession—as it is indeed to Great Britain that the credit, at all events, for such a wonderful production certainly belongs.

In spite of the vast range of machines to be dealt with there is no difficulty in knowing where to begin, as the feature which is bound to create the greatest interest is undoubtedly the adoption of the combination of reciprocating engines with a turbine which has already been announced an arrangement designed, as is well known, to secure the maximum possible economy and which we understand has given remarkable results on the White Star liner Laurentic" The engines have been already briefly referred to and described in our issue of October 21st 1910 from particulars largely supplied by the builders but in describing them now from a personal inspection we shall recapitulate some of the facts for the sake of obviating the need for constant references to a back number and to make this article complete in itself

In designing the machinery for a transatlantic passenger steamer it will probably be safe to say that there are two main points to be considered after that of safety namely economy and the comfort of the passengers—that is absence of vibration—and it is rather remarkable how well both these points are met by one and the same arrangement The introduction of the low pressure turbine allows the steam to be expanded down very much further than could be done in any reciprocating engine and so economy is obtained while its addition to a twin set of reciprocating engines enormously reduces the size of such engines compared with what would be necessary if only twin screws were adopted As the vibration as it affects the passengers is largely a question of the total mass of the reciprocating parts in relation to the mass of the ship herself it will be obvious that the smaller each set of engines can be made the less will be the vibration felt by the passengers so that there will be a point when the relation between ship and engine will be such that the reciprocating engine will cause no more annoyance to the passengers than would a turbine Of course the better balanced an engine is in itself the larger it may be in relation to the ship so that in the case of the Olympic the engines, which are balanced on the well known Yarrow Schlick and Tweedy system are comparatively large It is perhaps hardly necessary to add that the combination while thus retaining all the advantages of a complete turbine installation obviates its great draw back and provides a ready and practically full powered means of reversing

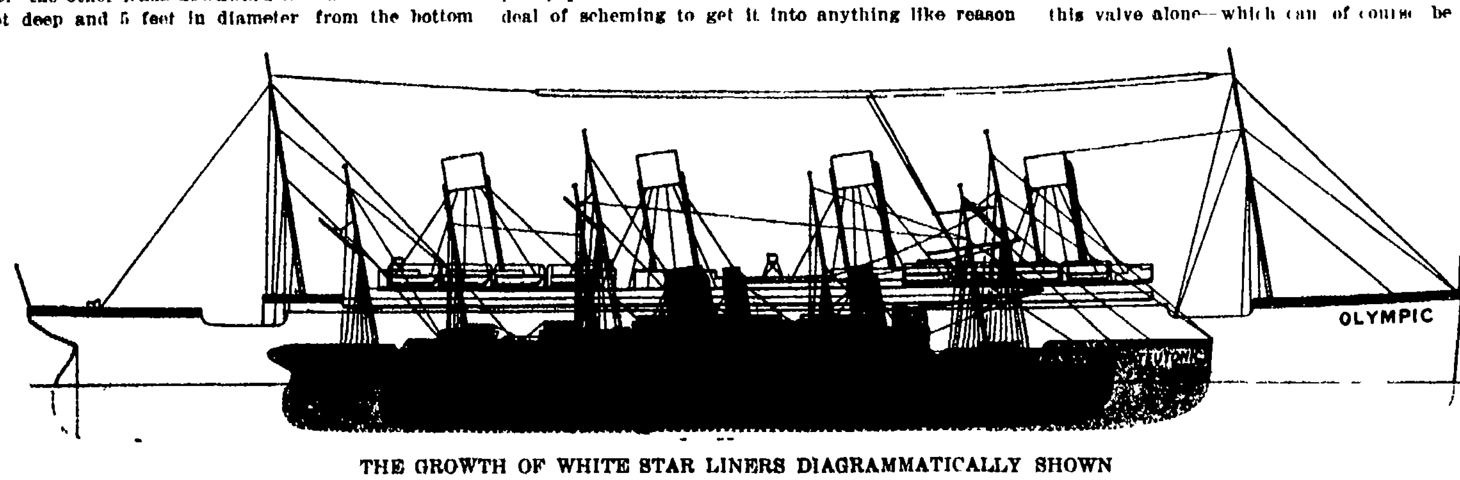
Making this our opportunity for leaving generalities and coming to particulars it will be well to begin by describing how this reversing is done as we must admit that, before going fully into it on board we anticipated that it would entail considerable complication and multiplication of duties for the engineer but this is not so The exhaust from each forward low pressure cylinder is led out along the front of the engine into a steel T piece on the after low pressure cylinder where it is joined by the exhaust from that cylinder and continues through the water tight bulkhead Here it enters an enormous change-over valve One branch from this valve leads to the condenser the other leads downward into a strainer some 9 feet deep and 5 feet in diameter from the bottom of which a pipe leads at right angles to the low pressure turbine, it is to be noted that the whole of this is in duplicate; and that there are two change-over valves, two condensers, and two steam admissions to the turbine. The change-over valve consists simply of what may be called a deflector piston in a casing, when the piston is up, the steam is deflected or guided downward to the turbine, when the piston is down, it is guided across the casing and out to the condenser

The pistons of both these change-over valves are inter connected through levers to a common Brown's hydraulic cylinder reversing gear on the bulkhead which is controlled by a lever on the starting platform close to the main reversing lever When the order to reverse is given the engineer has simply to pull over his lever for the change-over reversing gear and pay no further attention to it he need not even



WHITE STAR LINER OLYMPIC —BOILER ROOM NO 3 LOOKING AFT

wait a second before pulling over his lever for the main engine reverse gear The turbine will have been shut off altogether—except from the condenser and the exhaust from the main engines will be passing direct into the condenser so that the ship has become an ordinary *twin screw* job and will be *handled* as such without further reference to the turbine until she has settled down again for a straightaway run when the change-over valve will be returned to its original position and the turbine again supplied with low pressure steam the whole operation is simplicity itself The design of the change-over valve is a very pretty piece of work and must have required a great deal of scheming to get it into anything like reason



THE GROWTH OF WHITE STAR LINERS DIAGRAMMATICALLY SHOWN

able dimensions—especially when it is considered that the bore of each exhaust pipe—which by the way is of lap-welded steel with a strap riveted over the weld —is no less than 5 feet. Expansion in a case like this, when everything is so heavy and so many rigid connections have to be made is a matter requiring careful consideration, especially in view of the absolute necessity of excluding any trace of air from the pipes, which practically bars the ordinary stuffing-box form The difficulty has been overcome by the provision of a number of concertina joints one between each rigid connection consisting of two thin steel disks, riveted to and about 3 feet larger in diameter than the steam pipes and riveted together at their periphery through a steel ring the flexibility thus provided by the steel disks is found to give ample breathing capacity

While on the subject of piping it may be of interest to sketch the connections from the boilers These are of welded steel and in duplicate right up to the engine room bulkhead here are the main stop valves 21½ inches diameter each with a large separator and a cross connection which allows either range of piping to be used for either or both engines Forward of this bulkhead on each pipe is a balanced emergency stop valve which can be closed in a few seconds in case of need In addition to the stop valves on the main engines there is an auxiliary valve of comparatively small diameter but large enough to pass sufficient steam to run the engines at slow speed so that this valve alone—which can of course be opened and closed quickly compared with the big stop valve—is used when handling the engines Altogether in spite of the non reversing turbine and the huge size of the engines—cylinders 54 inches 84 inches 97 inches and 97 inches diameter by 75-inch stroke—the gentleman on the bridge ought to have no cause of complaint against the engine room when maneuvering this unwieldy charge. In the ordinary way a pipe arrangement would be considered a very dull subject, and

would certainly not furnish material for more than two of these lines but we venture to think that the installation under discussion presents sufficient points of interest to warrant our prolonging our description still further After passing through the turbine the steam leaves the top of the casing through a rectangular hole on each side and passes to the two pear shaped condensers the only auxiliary exhausting into the main condenser being the steering engine to accord with White Star practice Each of these rectangular holes is fitted with a big electrically-operated sluice valve which will enable the turbine to be completely shut off from the condenser in case of damage to the casing The eduction pipes are of welded steel and extend from the sluice valve casing out to the whole length of the condenser, so thoroughly distributing the steam over the tubes

With the steam from twenty nine big boilers to be dealt with it may well be imagined that a lot of circulating water will be required and this is provided by two circulating pumps with independent steam engines having cylinders 13 inches and 22½ inches in diameter—truly a decent little tug engine in itself The hole in the ship's side for the circulating injection was in the case of the Titanic which we saw on the stocks being used by the workmen as a means of ingress to and egress from the engine room After leaving the main engines the pipe arrangement naturally becomes inextricably mixed up with pumps etc but we will try and follow the combination a little further Copper pipes are used here and generally for the smaller steam pipes off the main range and we noticed in the shops that the edges of the copper used for big bends etc are chamfered off for brazing by means of a power hammer which should help to produce good work We were rather surprised to find that no higher vacuum than 28½ inches is expected from the four Weir dual pumps which are fitted though within ¾ inch of the barometric pressure could probably have been reached if desired The Weir arrangement has a single 22 inch diameter steam cylinder operating two 36 inch diameter pump cylinders connected together by a rocking lever the one cylinder pumps the water to the hot well in the ordinary way the other is connected to the upper part of one arm of a V in the air pump suction pipe into which the air and vapor rise and are drawn off leaving the water pump free to work at its maximum capacity From the hot wells two pairs of 14 inch duplex type pumps deliver to the oil filter and the surface and contact feed heaters placed in the reciprocating engine-room the latter on the level of the saloon deck and clearly shown in the elevation and cross section whence the hot feed passes down with a good head to the four 19 inch main Weir feed pumps and so to the distributing valves on the engine-room bulkhead It will be understood that the air hot well and centrifugal pumps and main condensers are in the turbine engine room while the main feed together with the auxiliary condenser and numerous ballast bilge and sanitary pumps and the two Hall's CO_2 refrigerators are in the reciprocating engine-room There are no pumps whatever on the engines and all are in duplicate so that when four are mentioned it will be understood that two will be sufficient in the ordinary way to do the work In addition to those auxiliaries already mentioned there are two turning engines one auxiliary condenser and circulating pump ash ejector pumps three lubricating oil pumps four Railton and Campbell ash hoists twelve See ash ejectors and three 60 ton evaporators about ninety in all together with others electrically driven which will be referred to later

We trust we may not be thought to have attempted to cook our hare before we have caught him in thus detailing the pipe arrangement before we have got our engine in place so to speak but we think our description has up to the present maintained a fairly logical sequence None the less we had perhaps better retrace our steps and get ahead with a general outline of the main engines

The low pressure cylinders are arranged one at each end as usual with the balancing system adopted and each has two flat valves worked off a common cross head by a single set of double-bar links and eccentrics and each having an ordinary balance cylinder No doubt the two valves and crosshead result in a slightly greater total weight than a single valve but this should be more than compensated for by the greater ease of handling and of maintaining steam-tightness A single piston valve is fitted on the high pressure cylinder and two on the intermediate pressure In studying the engines of this ship we could hardly help being struck by the wonderful way in which the old link gear still retains its place in the favor of marine engineers in spite of the many good radial gears that have been put upon the market from Hackworth Joy, Marshall Brock and Morton onward but at the same time we could not help feeling that even if we were directly interested in any of these gears, we should have to admit that their chief claim to recognition—that of saving space fore and aft by bringing the valves out to the front of the engine—would in this case have very little weight, even though the steam distribution might be a little better, the whole space devoted to the machinery is simply enormous– in fact, it may be said that it extends for practically the whole length of the ship

Certainly the impression gained in all three engine-rooms is one of vastness—vastness not so much of the machinery though that is big enough a cylinder column alone for instance weighing 21 tons as of the space available for and devoted to it over 90 feet across! The electric light engine room for instance to which we refer elsewhere is bigger than many a big ship's main engine-room However to return In spite of the big weights apparent weight does not appear to have been wasted and we noticed that the weigh shaft is tapered down in diameter outside the intermediate and high pressure valve gears where it has only a single set of links to carry Each set of links by the way has its own separate adjustment, so that the Brown reversing gear may always be set at full stroke whatever the cut-off required in each cylinder Running at 77 revolutions per minute with a boiler pressure of 215 pounds per square inch about 30 000 indicated horse-power are expected to be obtained which with another 15 000 from the turbine at 165 revolutions per minute should give the ship a speed of about 21 knots though it is a curious thing that all the crack White Star boats have made their best passages at least ten years after their launch—the old Britannic if our memory serves us right making her record after some twenty six years service

An interesting problem arises in connection with the overhaul and examination of such an engine as this where the built up crank shafts weigh somewhere in the neighborhood of 120 tons each and where a single nut off the bottom end is more than a man can conveniently deal with single handed the engine room floors have had to be specially strengthened to receive such trifles as a main bearing cap and altogether the engine seatings built up on the tank top are a study in themselves Further electrically operated lifting gear is provided on the tops for handling covers pistons etc while below are electrically driven winches with tackles etc for dealing with bearing caps bottom ends and eccentric straps The turbine casing also has its own electric motor and lifting gear while four machined vertical steel columns are fitted in guides on faces on the casting to insure its seating properly and without damage to the blades In this connection we would draw attention to one point which struck us rather forcibly in the course of our inspection of this turbine—which is of course of the ordinary Parsons low pressure type—though it is a point which is quite well known by now among marine engineers We should incline to the opinion that the sea-going engineer would desire to make the same sort of inspection of the interior of his turbine—the rotor etc—as he does of the piston valves etc of his reciprocating engine after a round trip This however would be no easy matter in spite of the splendid lifting arrangements which are provided nor could it be accomplished in the length of time usually available at the end of an Atlantic trip The number of joints to be broken the size of the joints and the need for absolute air not steam tightness and the weight of the various parts eduction pipes casing top etc which would have to be moved would obviously involve several days work though we have no exact information on the subject and it seems that the ordinary sea going axioms may be permissibly and in fact are safely ignored in the case of turbines

An electric motor is provided for turning the turbine though the reciprocating engines have steam turning engines The turbines were not built by Harland & Wolff but there is now under construction at their yard an enormous new shop the framework of which is of beautiful design as combining lightness with strength and the whole of this is to be given up to the construction of turbines in the future In fact the patterns for a set have already been constructed No less than fourteen collars are fitted on the thrust shafts of the Olympic" which with the line shafting are hollow a 9-inch hole being bored from end to end Loose couplings are fitted on the tail shafts of the reciprocating engines to enable them to be withdrawn outboard for examination—a very necessary arrangement for a 28-inch shaft There are eleven plummer blocks on the turbine shaft all of which are provided with forced lubrication at a pressure of about 28 pounds per square inch obtained by gravity from a tank high up in the turbine engine-room holding a ten minutes supply in case of failure of the pump The oil escaping from the bearings is collected in special drain tanks and pumped through strainers and coolers back to the gravity tanks; the tubes of which these coolers are composed are fastened into an oval just beyond the point where they fit into the tube plates, and it is found that the oil does not tend to harden on the surface as was the case with circular tubes, a very cheap and simple method of getting over the difficulty

The days when the engineer had to stand by the throttle and do his best to close the valve at the correct moment to prevent racing and open it again in good time to allow the engine to get away when the propeller again became immersed are, of course, long since gone by and the well-known Aspinall governor is fitted to make a thoroughly good job of what a man at the best could only make a poor job of, fitted on a special rocking arm in the absence of the usual air pump lever this is connected to the throttle of each engine and forms a very perfect mechanical governor while the turbine is similarly cared for by means of a ball governor acting on the Brown's gear which operates the two change-over valves so that in the event of a fracture of the turbine shaft, or loss of the propeller the turbine would be shut off and the reciprocating engines would go on their way with unruffled serenity

As is probably well known the White Star Company only permits the use of forced ventilation and not of any system of forced draught on its ships and though this tends to increase the grate area necessary yet with a height of funnel of 150 feet above the bars there cannot be much difference between the two with the advantage of induced in stead of forced draught It is rather curious to consider what a great advantage from a steam producing point of view is this great height which is after all rendered necessary strictly speaking solely by æsthetic demands and by the desire to obtain a smart looking ship of which the proportions shall be well balanced the top weight, however of four oval funnels 24 feet 6 inches by 19 feet and over 70 feet above the boat deck, with their inner casings must be enormous The boilers themselves are twenty nine in number—twenty four double-ended and five single-ended each 15 feet 9 inches in diameter the former being 20 feet long and the latter 11 feet 9 inches with plates 1 11/16 inches thick the shells having only one joint The comparative insignificance of the battery of boilers in relation to the ship is illustrated by the fact that the boilers are placed in the ship no less than five abreast although actually a walk from end to end of the boiler rooms is a big undertaking Thwartship bunkers are placed between each pair of boiler fronts with a bunker door opposite each boiler so that trimming on the plates is reduced to a minimum The wing bunkers are above the level of the boiler tops each wing boiler being secured by rolling chocks direct to the skin of the ship Even the uptakes on a job like this are a source of wonder they are even in fact provided with expansion joints

Naturally in such a ship many interesting little gadgets are to be found in the course of a tour of inspection of the stokeholds and elsewhere for instance each stokehold is provided with Kilroy's stoking indicators one for each boiler—neat little electrically operated signal disks with loud gongs which give visible and audible intimation to the fireman as to the exact moment when each furnace is to be fired The instruments are so arranged that there shall be the minimum number of doors open at the same time, and no two opposite doors in the same double end boiler shall be open together The interval between the times of firing any one furnace are under the control of the engineer and can be varied if found necessary but when once set insure perfect regularity of firing and so promote economy and smokelessness The current is provided by the ship's circuit so that when set and the switch opened the gear is automatic and requires no further attention

Even the whistle arrangements, embodying as they do a device designed by Mr W J Willett Bruce, of the White Star Company to insure a supply of perfectly dry steam immediately the whistle is required, are out of the ordinary though they are what are now used on all the White Star boats An automatic non return valve having a drain leading into the exhaust system is fitted in the whistle valve casing so that there can be no accumulation of water to sputter and muffle the sound when the lanyard is pulled, and a clear blast immediately follows. In addition to this, an electrically controlled timing apparatus operated by current from the lighting circuit is provided by which the whistle can be blown at perfectly regular pre-determined intervals in order to comply with the Board of Trade regulations for signaling in a fog, so relieving the tension on the nerves of the passengers, and reducing the duties of the officers of the watch. Another provision toward safety is the rather obvious arrangement for controlling the closing of the watertight doors in the bulkheads. These are kept open by means of a clutch kept in engagement by a [illegible]

[illegible] can be lifted by an electric arrangement [illegible] by a float in the bilges, so that any water [illegible] below the floors to more than a pre-[illegible] depth will raise the float, release the clutch [illegible] the door—this taking place comparatively [illegible] owing to the pneumatic cushion cylinder on [illegible] having its piston connected to the door There is also a hand control by which a man who might be trapped below could delay the closing of the door till he had made good his escape These points are detailed to show the care and thought which have been expended in even the smallest items of the equipment of the ship

There are also Silley wedge action smoke-box door fasteners which do away with the usual many handles and tend to keep the doors from warping a complete outfit of telegraphs to indicate the requirements of the engine-room in regard to steam etc while each stokehold has its own pumps in their own little engine-room completely screened off from the coal dust Some 176 firemen will be carried with 72 trimmers and these have their own special passage and spiral staircases leading to their bathrooms and quarters so that they never need be seen by the passengers while on their way to or from duty We should not omit to mention, too, that there is a series of escape trunks leading from the engine-rooms and stokeholds to the upper deck to enable the men to escape in case of the ordinary means of egress being rendered useless by accident.

THE ELECTRICAL OUTFIT

Those who remember the early days of the introduction of electricity on board ship when any old other wise useless corner was good enough to stow the dynamo in would appreciate the great importance to which this department has now attained on board ship by an inspection of the palatial room devoted to the generating plant on this ship The whole width of the ship—except for the space taken up by the three shafts and their plummer blocks—for a length of some 64 feet and 24 feet high is entirely given up to it Here are situated the four sets of 400-kilowatt multipolar dynamos, each driven by a three-cylinder compound vertical inclosed Allen engine having cylinders 17 inch, 20-inch and 20 inch diameter by 13 inch stroke running at 320 revolutions per minute with a steam pressure of 180 pounds per square inch Forced lubrication is, of course used with special arrangements to prevent the oil getting into the cylinders and so to the boilers, and we were interested to note that Renold silent chains instead of belts were used for driving the tachometers and that watt meters are fitted to each set It may be mentioned here that in addition to these four sets there are two 30-kilowatt sets having cylinders 9 inch and 12-inch by 5 inch running at 380 revolutions per minute, fitted on the level of the saloon deck above the water line, so that if the main generating room were flooded it would nevertheless be possible to have sufficient light to avoid panic among the passengers and for signaling purposes etc It will naturally be asked why reciprocating engines have been adopted for the dynamos instead of turbines and this question received very careful consideration on the part of the builders and is largely a commercial rather than a mechanical one The whole of the exhaust from these engines was required for the feed water heater so that the economy of turbines would have been seriously interfered with and this favored the adoption of the reciprocating engines

The whole of the installation has been most carefully thought out complete wiring plans having been prepared giving the position of every switch light and motor throughout the ship and what this involves may be guessed from the following list of machines for which electricity is used in addition to the arc and incandescent lights Deck cranes cargo, boat and engine-room winches, Waygood s elevators for first and second-class passengers and lifts for stores mails, and pantries eight 55 inch two 50-inch and two 40-inch stokehold fans delivery fans for cold hot and warm air cylinder lifting gear, turbine turning, and turbine lifting pneumatic conveyor Marconi apparatus gymnastic apparatus, ice rockers domestic machinery such as dough mixers, potato peelers, roasters knife cleaners, slicers, whisks, etc., sluice valve operating gear steam whistle, sounding machines illuminated signs clocks, water-tight doors, helm indicators, submarine signaling wireless telegraphy telephones (loud speaking and ordinary) bells, cabin fans heaters hot plates and similar appliances, electric irons and electric baths. The total number of motors is between 140 and 150 from ½ to 40 brake horse-power while there are 450 heaters from 750 to 2 500 watts each

The dynamos are compound wound the equalizer cables being led to interconnecter switches situated below the deck at a position approximately equidistant from the four machines with a view to minimizing and equalizing the resistance when running in parallel The positive cables run to the main switch pillars and thence to the feeder panels or switchboard proper which is placed athwartships on a raised platform or organ loft which runs right across the ship arranged as it is to distribute some 20 000 amperes at 100 volts—equal to the central station of a good large town the heating lighting ventilating and power each account for about 25 per cent of this The adoption of tantalum lamps which are fitted throughout (with the exception of some ordinary incandescent lamps in the engine-room) permitted the voltage to be reduced to 100 which it is estimated will result in a great economy in spite of the higher cost of the metal filament lamps The latter have been found to be quite suitable for use on shipboard except where there is any pronounced vibration On this same platform are arranged the four main switches and contact breakers above mentioned one for each dynamo the levers of each of which there are five being interlocked so that only the correct sequence of operations can be carried out The operator faces the generating plant and has under his control an illuminated sign actuated by a round handle by which he can signal to the engineer in charge of the generating plant for more or less speed or for a given machine to be started or stopped The whole switch when completed is of course completely cased in by planished steel sheets All switches etc are connected to illuminated and numbered signs so that the effect of the movement of any lever is clearly and unmistakably indicated From the feeder panel 46 leads of 91/13 cable are carried together with their returns in two steel water tight trunks through the various decks distributor boxes are fitted on each deck from which the leads are sub-divided to the various circuits so that all the wiring is kept as compact as possible all wires leading through a water tight bulkhead are collected together in a steel tube filled with bitumen for the sake of neatness while maintaining water tightness We noticed a neat method of leading the cables to the stokehold fan controllers The cables are fitted permanently into screw plugs the holes for which are bored and tapped in the joint of the cover so that they can be placed in position and the cover screwed down making a simple and yet water tight joint These controllers by the way have rods supported on ball thrusts leading down into each stokehold so that they can be operated either from above or below the ball thrusts enable the gear to work with so little friction that the different positions on the controller can be easily felt even at the bottom end While on the subject of electricity we would like to draw attention to the method adopted for lighting the ship while being fitted out The whole of Queen s Island is covered by cables lead ing from the main generating station in the works but the Olympic is lying beyond the reach of these so the firm have installed four dynamos on the main deck of their tug the Jackal which is lying along side and have made her into a portable central station supplying the whole ship a fire engine has also been installed with hydrants all over the ship and fire drill is carried out once a week This with the big floating crane and the special steel gangways already referred to is suggestive of the huge capital outlay to be considered in the construction of such a ship which alone puts the work beyond the reach of all but a few firms

OTHER AUXILIARIES

There is, of course much other auxiliary machinery in all parts of the ship but we will only refer to some of the more important items

In order to keep the weight of the anchors down as much as possible and yet to comply with the Board of Trade regulations an unusual arrangement has been adopted in having a hole in the stem to allow for a third anchor which is housed on the forecastle the two side anchors housing in the hawse pipes as usual Two large vertical steam windlasses by Napier Brothers are provided for the side anchors the starboard one of which has additional clutch gear operating through bevels to a worm and wheel on a large central drum grooved to take the huge steel wire which is fitted to the center anchor instead of the usual cable the thrust block on this worm shaft is quite a striking piece of machinery and gives some indication of the power required for dealing with this important part of the ship s equipment The big anchor weighs some 15½ tons Two warping engines are also fitted under the forecastle which in itself forms a small engine room

Right aft we were faced with a feature of which we are afraid we could hardly appreciate the precise value or at any rate the value commensurate with the cost involved Here we found a pair of enormous three-cylinder steam steering engines of the firm s well known make Only one set is in gear at a time the other set being a stand-by which can be quickly engaged by means of screw jacks embodied in the framing which slide the base plate along for the distance necessary to engage the teeth of the pinion in the rudder quadrant the bends in the steam pipe being sufficiently flexible to allow of this without the need for making any joints We should have thought that the rudder head would have been more likely to prove the weak spot failure of which would of course render both engines useless while the ship could be safely navigated into port by her propellers only However perhaps it is not for us to criticise a feature which a firm of such enormous experience as the White Star Company has apparently found to be desirable The gearing of the engines is of the double helical or herringbone type cut from the solid Citron gear It is designed for silence and strength and we were informed that it is perfectly noiseless and entirely does away with back lash The pinion on the gear shaft meshes with the teeth on the quadrant which is loose on the rudder head but the quadrant is connected by springs to a double tiller below which is keyed to the rudder head so that the engine and gearing should be relieved of all shocks which in view of the fact that the rudder weighs 100 tons and is 15 feet broad will not be inconsiderable An emergency tiller is also fitted which can be connected up to the two warping engines in the wings in case of damage to the quadrant the teeth of which are in interchangeable sections bolted to the casting The control is by means of a Brown s telemotor from the bridge actuating the steam valves There is also fitted a Brown s Economic valve—or get out of the way valve if we may be allowed to coin a word to prevent leakage of steam while the engine is standing due to the absence of lap on the piston valves This valve consists of a conical seated valve in the steam admission port with a coned projection extending into the engine valve chest and when closed shuts steam completely off the engine When the engine valve is moved by the telemotor it acts on the coned projection and pushes the valve back off its seat and admits steam a strong spring returning the valve to its seat when the engine valve has resumed its central position We understand that the engines are capable of putting the helm from hard a port to hard a starboard in twenty seconds

Though it is practically impossible and not always desirable to describe all the details of such a mammoth installation as this we think we have outlined the main features of interest without dwelling upon points which are matters of too common knowledge For instance we have given no description of the turbine as details of one set such as this are common to many others which have frequently been described in recent years and a Parsons turbine does not present so many possibilities of design as a reciprocating engine—at all events outwardly To go over such a ship while under construction is a liberal education in itself and affords a better idea than could the completed ship of the wonderful organization necessary to enable the swarms of men employed in the ship construction engineering electrical and other branches to work synchronously and harmoniously together in the rapid completion of the whole structure

Temperature and Humidity of Workrooms Etc

The effect of different temperatures and degrees of humidity in the air in different workrooms, mines, etc., has been tabulated by a German, who sums up his observations and recommendations as follows

At a temperature of 10 deg. C. (50 deg F) the worker is liable to catch cold if not protected specially by warm clothing. If the work is severe physically and the body thereby greatly heated, a temperature of at least 12 deg C (53 6 deg F) is necessary for comfort and health If a lower temperature is unavoidable, then thick clothing is necessary If the work is physically less exacting with ordinary clothing 18 to 20 deg C (64 4 to 68 deg F) and about 40 per cent of saturation is right Miners tunnel laborers bakers, etc, who are compelled to work where the temperature is 30 to 56 deg C (86 to 132 8 deg F), with humidity 60 per cent and even over, are in danger of heat-stroke unless special precautions be taken to prevent it For temperatures over 50 to 60 deg C (122 to 140 deg F) where the air is dry—say with humidity 20 per cent—as is the case with glass blowers and distillers the work is not so exacting by reason of the low degree of moisture

The two sets of workmen mentioned last should as far as is practical strip for their work and should enjoy good ventilation also should use heat veils and screens

Airship Anchorages

By Major O C von Verschuer

The airship cannot become a practical means of transit until its safety has been assured by an organ ization as thorough and comprehensive as those of railways and steamship lines Airship harbors and anchorages are especially necessary The loss of the stately passenger airship Deutschland was due to the lack of suitable anchorages

The peculiarities of airship traffic will probably develop stations of three classes

1 Terminal stations, analogous to railway termini

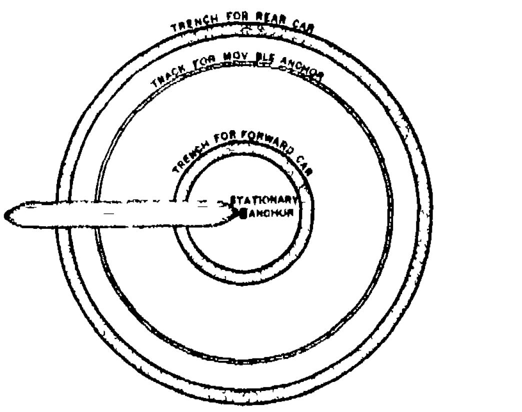


Fig 1 – Plan of Airship Anchorage

in large cities and provided with shelters or sheds and every requisite for the preservation maintenance equipment and repairing of airships

2 Way stations at suitable points in the vicinity of small towns and villages

3 Emergency stations in places well sheltered from the wind such as valleys surrounded by forests, and situated if possible near towns and villages

Costly shelters will not be required at way stations for the stops at these stations will usually be short and even a longer stop caused by adverse winds or a disabled motor or propeller will not necessitate the housing of the airship if the anchorage is pro vided with appliances which will assure the safety of the vessel even in a violent storm

An anchorage suitable for a Zeppelin airship can be constructed as follows The vessel is secured by a stationary anchor placed at the center of a sheltered level field about 1 000 feet in diameter and also by a movable anchor in the form of a wheel rolling in a hollow circular track about 250 feet in diameter The stationary anchor is attached to the bow and the movable anchor to the stern of the airship which therefore automatically keeps it head to the wind

In order to allow the bottom of the cylindrical hull to be brought very near the ground two circular trenches 6 or 7 feet deep and concentric with the anchor track are provided for the reception of the two cars which move along their respective trenches as the airship veers with the wind On account of the downward pressure of the wind the bottom of

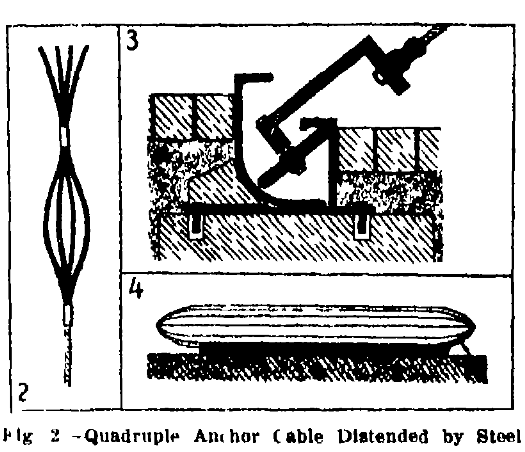


Fig 2 – Quadruple Anchor Cable Distended by Steel Springs Fig 3 — Movable Anchor and Its Track Fig 4 — Airship at Anchor Showing Protective Apron

the longitudinal gangway should be about 20 inches above the surface of the grass grown soil and should be protected at its after end by leather bags filled with wool or shavings

Thus anchored the airship is little liable to injury from head or side winds The injurious effect of puffs of wind which force themselves between the hull and the ground and which contributed largely to the disaster that befell the Zeppelin II" at Limburg may be prevented by surrounding the lower part of the hull with an apron of sailcloth with its lower edge stiffened by light metal rods and weighted with sand bags (Fig 4)

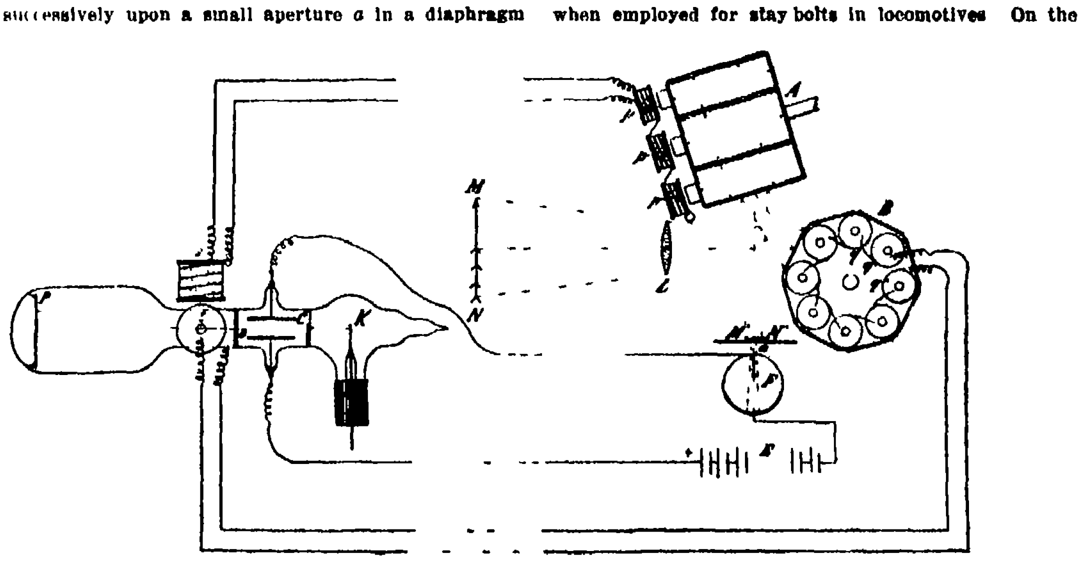
In order to prevent the rupture of anchor cables and other damages caused by sudden gusts of wind, it is advisable to employ a group of four cables, stretched over four curved steel springs wrapped with wire (Fig 2) The elasticity of this contrivance will equalize the tension, diminish the effect of gusts and protect the airship and its connection with the cable from violent shocks.

The cost of constructing an anchorage of this sort would not be out of proportion to the importance of the purpose for which it is designed —*Umschau*

Prof Rosing's Electric Eye —A New Apparatus for Television

Several methods of television, or seeing at a distance with the aid of wires and electric currents have been announced in the course of the past decade, but none of these methods has come into practical use The Russian journals now announce that Prof Rosing, of St. Petersburg has solved the problem of television The following description of Rosing's method and apparatus is taken from an article contributed to *Cosmos* by Jacques Boyer who derives his information from the *Bulletin* of the International Technical Society of St Petersburg

The electric eye as Prof Rosing calls his apparatus is illustrated in the accompanying diagram, of which the right hand part represents the transmitting station and the left-hand part the receiving station In the diagram the stations are shown connected by six line wires but the number of wires can be reduced to four At the transmitting station two drums *A* and *B*, covered with plane mirrors rotate on mutually perpendicular axes in such a manner that every point of the image *M N* which is formed of the object *MN* by the lens *L* and the mirrors falls successively upon a small aperture *a* in a diaphragm



PROF ROSING'S ELECTRIC EYE A NEW APPARATUS FOR TELEVISION

Receiving station at the left – *K* cathode *I* fluorescent screen *C* condenser *O* diaphragm *P* electromagnets. Transmitting station at the right – *A B* rotating drums carrying mirrors and magnets, *M N* object *L* lens *M N* image *A* diaphragm *F* photo-electric globe *B* battery *p p' p" g g' g"* coils

placed before a glass globe *F* The interior of the hemisphere opposite the aperture *a* is lined with an alloy of potassium sodium or rubidium which is con nected with the negative pole of the galvanic battery *E* The negative charge which the alloy thus acquires is carried away by the negative ions which the alloy emits under the influence of the illumination which it receives from the aperture *a* In this way a charge varying in magnitude with the intensity of illumination or the brightness of the point of the image *M N* opposite the aperture *a* is transmitted to the condenser *C* at the receiving station, through the wires connected respectively with the alloy and with a positive electrode which occupies the center of the globe *F*

The rotating drums *A* and *B* which carry the mirrors also carry magnets which as they pass the coils of wire *p p' p"* and *g g' g"* generate alternating currents which are transmitted to the receiving station where they energize the electromagnets *s* and *t*

A pencil of cathode rays emanating from the cathode of a Crookes tube *K*, traverses the common field of the two electromagnets the axes of which are mutually perpendicular and is thus subjected to deviations corresponding to the displacements of the image *M' N'* with respect to the aperture *a* at the transmitting station The result is that the luminous point produced by the impact of the pencil of cathode rays upon the phosphorescent screen *p* moves in exact correspondence with the relative movement of the aperture *a* over the image *M' N'*

Before the pencil of cathode rays enters the electromagnetic field it passes successively through a small orifice in a diaphragm (shown in the figure but not lettered), between the plates of the condenser *C*, and through a small orifice in a second diaphragm *o*. The relative positions of the two orifices and the cathode *K* are such that the rays do not traverse the second orifice *o* unless they are deflected by the electrostatic force exerted by the charged condenser, so that the fraction of the pencil that passes through the orifice *o* is proportional to the deviation, and therefore to the charge. Hence the intensity of the active pencil and the brightness of the fluorescent [illegible] are proportional to the charge of the condenser, and consequently to the brightness of the point of the image *M' N'* which momentarily illuminates the photo-electric alloy at the transmitting station.

In consequence of these electromagnetic and electrostatic actions exerted upon the cathode rays, every point of the image *M' N'* and the object *MN* is reproduced with its proper relative brightness, on the fluorescent screen *p* at the receiving station As the entire operation is repeated forty times per second the fluorescent screen presents to the eye, in consequence of the persistence of retinal impressions a motionless picture of the object *MN* The fluorescent screen the electromagnetic field, the diaphragms and the condenser are of course inclosed in the Crookes tube with the cathode *K*

Aluminium Copper Alloys

The British Association of Mechanical Engineers has a committee whose business is research concerning the properties of various alloys which are now coming so rapidly into use A recent report deals with alloys of aluminium and copper Various experiments have shown that such alloys are erratic in behavior especially under tests for yield point and at high temperatures

Copper alloyed with 7 per cent of aluminium was shown in some experiments to give disastrous results when employed for stay bolts in locomotives On the contrary these alloys show good results in other ways It has been shown that copper alloyed with from 1 to 10 per cent of aluminium becomes practically in corrodible in sea water But this does not hold for tank water

Cement-Protected Iron

The use of cement to protect iron is not a new invention At Brest the demolition of subaqueous con structions has brought to light iron bars which were thus covered and which have remained in perfect condition for more than 100 years At Rochelle a bridge erected in the fifteenth century was found to contain cement protected iron and the metal had not suffered from the effects of moisture

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The International Hygiene Exposition at Dresden

The International Hygiene Exposition which was opened in Dresden last month after four years of diligent but unostentatious preparation and which will continue open until November, is called an exposition in default of a better name. The real purpose of this great enterprise is the promotion of the health of humanity. A hygiene exposition was held in Berlin as far back as 1882, when the science of hygiene was in its infancy, and small local exhibitions of similar character have since been held in various countries, but none of these compared in extent and importance with this year's international exposition at Dresden, which forms a comprehensive review of everything which the mind of man has devised for the preservation and promotion of human health since history began.

The immense mass of material which has been collected in accordance with this far-reaching plan is divided into five departments, each of which constitutes an extensive exhibition in itself. These include a scientific, a historical and ethnographic, a popular, and a sport and exercise department, with each of which are associated appropriate parts of the fifth department, devoted to industries and manufactures. This fivefold division is a happy idea, and it possesses the great merit of giving proper recognition to the needs, tastes, points of view and powers of comprehension of each individual visitor.

The advantage of separating the scientific from the popular department will be recognized after a moment's consideration. The exhibits of the scientific department chiefly interest the specialist, while those of the popular department appeal to the popular mind. It is desirable that the attention of the ordinary visitor shall not be burdened and distracted by things which do not interest him and which he does not understand, and it is equally desirable that physicians, students of

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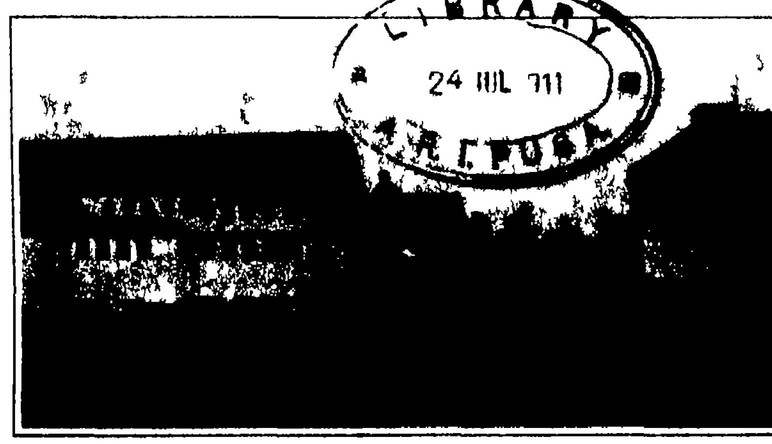
THE HALL OF CHEMISTRY AND SCIENTIFIC INSTRUMENTS



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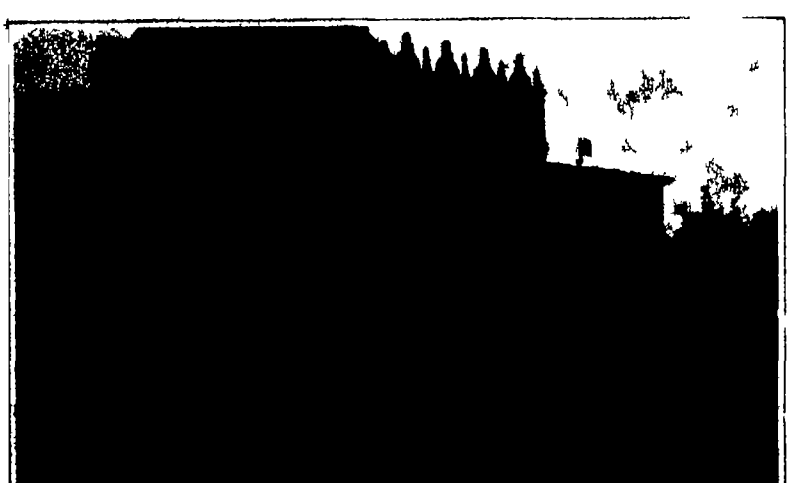
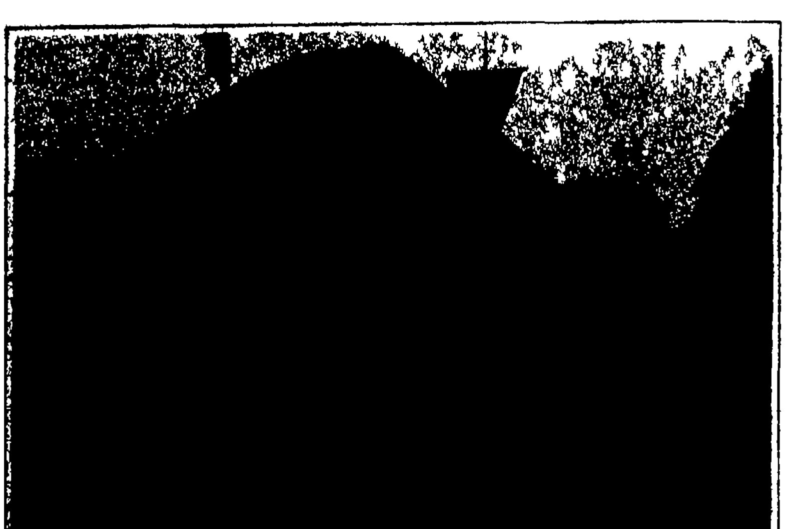
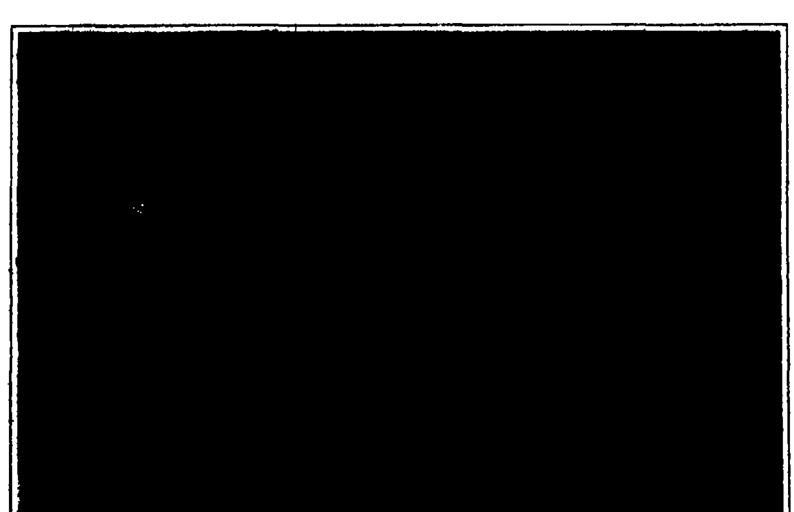


THE RUSSIAN BUILDING

THE JAPANESE BUILDING



THE AUSTRIAN BUILDING



A BRIDGE CONNECTING THE TWO EXPOSITION PARKS

THE INTERNATIONAL HYGIENE EXPOSITION AT DRESDEN

hygiene and public health officers shall be able to study the special exhibits which they alone can comprehend without being annoyed by the intrusion of material which is perfectly familiar to them and therefore superfluous.

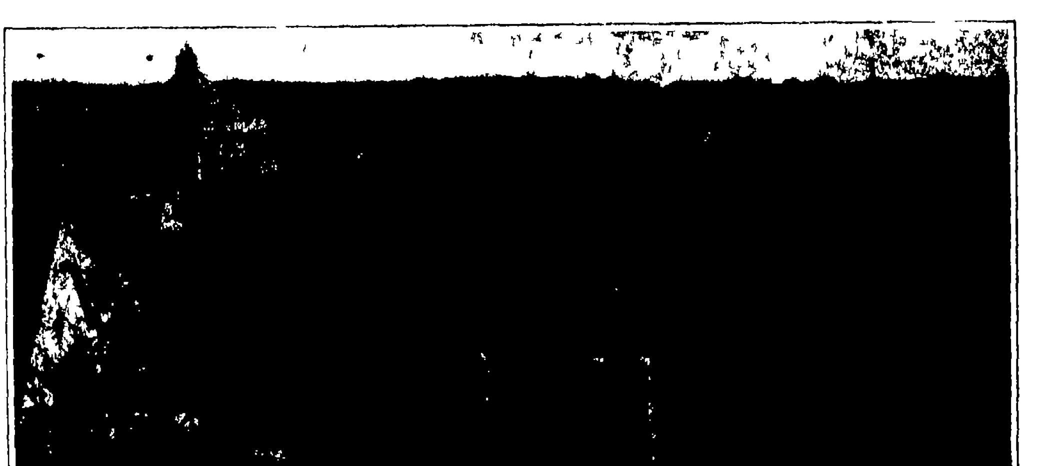
The historical department presents for the first time a complete and systematic history of hygiene. Here to the amazement of the average visitor is exhibited evidence of the attention which was devoted thousands of years ago to the health of the individual and the community. For example it is shown in a striking and original way that the basic idea which underlay all the laws and admonitions of Moses was the restoration of the physical health of his degenerated people as a necessary pre-requisite to their spiritual development. The religious precepts in which he embodied an advanced system of hygiene are the work of genius. It is probable that the Jewish race would have become extinct if it had not been preserved by this well-conceived plan of social hygiene.

This is only one of the examples which prove the incorrectness of the popular idea that hygiene is a very modern science.

The hygienic idea however is steadily progressing as is proved for example by the increasing popularity of athletic sports in which many brain workers find an indispensable source of physical recuperation. Hence sport will be represented at Dresden by a special group of exhibits and also by competitions for the championship of Europe in various events. Like other good things sport may be and often is carried to excess and has thus fallen into disrepute among large classes of the community. An endeavor will be made at Dresden to establish safe and sane limits which must be respected in order to secure the benefits and escape the evils of athletic sports. For this purpose a laboratory is provided in which the effect of various exercises upon the human organism will be studied in detail. No similar laboratory of sport is now in existence even in America or England, the two countries in which athletic exercises are most honored.

Associated with each of these departments is a group of industrial exhibits. The demand for space for these exhibits has made it necessary to enlarge some of the buildings several times. Certain industries which have had to contend against popular prejudices are represented far more extensively at Dresden than at any former exhibition. Single firms and societies have expended many thousands of dollars in order to convince consumers that the increased hygienic demands of the present day have been met by the newest industrial products.

The numerous buildings of the exposition distributed over some eighty acres of a municipal and a royal park present a harmonious and imposing appearance. The principal buildings are in the style of the classic Greek temple typifying the sacred character of health. Eminent judges have expressed the opinion that the Dresden exposition is architecturally one of the most beautiful expositions that the world has ever seen.



THE BRIDGE HUNGARIAN BUILDING AND POPULAR BUILDING

THE INTERNATIONAL HYGIENE EXPOSITION AT DRESDEN

China and Japan as well as America and all the nations of Europe are represented at this great exposition of hygiene. With few exceptions, each country has a special building. Individual cities with their smaller and consequently more intensively cultivated fields of public hygiene are also represented in large numbers.

The two great objects which the exposition is designed to promote are: First, the improvement of the hygienic conditions of the mass of the people which is the special function of municipal and national governments and second the instruction of the individual in the laws of health, as the influence of governments on the hygienic conditions of individual life is necessarily limited. The history of the International Hygienic Exposition may be said to have begun in 1903 in which year an Exhibition of German Cities was held in Dresden. Here and subsequently in Munich, Frankfort and Kiel was shown a special group of exhibits relating to epidemic diseases and their prevention, which proved so interesting to specialists and the general public alike that many persons expressed a wish that it might be enlarged to embrace the whole field of hygiene and continued in the form of a permanent museum or shown as a temporary exhibition, either of technical and compact or of general and if possible international character.

THE MAIN EXPOSITION BUILDING AND THE HALL OF CHEMISTRY AND SCIENTIFIC INSTRUMENTS

The field of hygiene has been extended enormously since the first attempt to illustrate it in a general exhibition was made in Berlin in 1883. Then there was only one professorship of hygiene in Germany, where now every university maintains a department of hygiene. Corresponding progress has been made in other countries. Hygiene has received much attention from lawgivers and administrative officers and has been popularized by the publication of many books and journals and by the efforts of hygienic societies whose members number many thousands. Industrial firms not always under compulsion have vied with each other in making their products unobjectionable on the score of hygiene.

It was evident, therefore that any State that should undertake to hold an international hygiene exhibition which should adequately represent present conditions must be prepared to perform thoroughly and conscientiously a great and difficult work, at considerable expense. In 1905 a committee met in Dresden to consider the possibility of holding such an exhibition in Germany. The obvious suggestion that the task should be assumed by the Imperial or by the Prussian Government was abandoned because the sentiment of Berlin was averse to the holding of great exhibitions. This narrowed the choice to the two great States of Bavaria and Saxony, that is, to their capital cities, Munich and Dresden. A favorable reply having been obtained from the Saxon Government, the most eminent hygienists of Germany, together with numerous representatives of the Imperial and State Governments, assembled in Dresden in 1906 to consider the project more fully. It was unanimously decided to hold the exposition if possible, in Dresden and to make its scope international and exceedingly broad. A board of directors was selected and a general plan was formed which required a subvention of two million marks, a guarantee fund of one million marks, the occupation of a large area of a city park and the adjoining royal park, and the gratuitous erection of the main exhibition building by the city of Dresden. After considerable difficulty and delay these modest demands were granted by the authorities, and the guarantee fund was raised by popular subscription.

All doubts respecting the reception which the project would meet in industrial circles were quickly dispelled. Prominent manufacturers pronounced the exposition peculiarly opportune and necessary because the industries which are most intimately connected with hygiene had not had opportunities at other great expositions, to show adequately and convincingly the progress they had made in satisfying the requirements of modern hygiene. Applications for space came in in embarrassing profusion as has already been mentioned.

In determining the general idea and plan of the International Hygiene Exposition little aid could be obtained from the study of previous expositions, the general character of which has scarcely varied in a hundred years. According to the orthodox program the special purpose and scope of the exhibition is first determined the public officials societies, firms and individuals interested are invited to take part, the exhibits contributed are grouped according to subject, and places of refreshment and amusement are added. In short the purposes and methods of the modern great expositions like those of the old-time annual fairs have been almost exclusively commercial.

Although exhibitors and visitors have derived much benefit from such expositions complaints have come from both sides. Many exhibitors have complained that the benefits derived did not compensate them for their outlay while visitors have objected that the accumulation of vast numbers of similar objects produced weariness made it difficult to find the exhibits of real importance and detracted from the educational value of the exposition. The question of reform in expositions has lately been much discussed and various methods of raising expositions to a higher plane have been proposed. All of these schemes, however retain the fundamental defect of previous expositions, dependence upon the will and caprice of exhibitors. The exhibits are determined largely by chance. Many interests decline to exhibit at all, others are represented by a few forms of little prominence, while still others demand an inordinate amount of space. Hence some groups are very defective, while others are overfilled.

The Dresden exposition, on the contrary, has been designed to present a clear, intelligible and complete picture of the present state of hygienic science and practice, so arranged that the ordinary visitor can obtain much information in a short time and that the specialist can quickly find the objects that interest him. This involves the division of the exhibits into sharply defined groups, shown in separate buildings. In ordinary expositions little attention is given to the visitors' capacity for understanding and appreciating the exhibits. The average visitor, for example, stares at a machine which is a marvelous piece of [illegible]

impressed by its size, complexity, bright polish and swift and silent movement, and goes away without the slightest idea of its real nature and value A little elementary information would make a visit to the machinery hall far more interesting and profitable At Dresden each limited group of objects is accompanied by instruction in the theory and history of that group

The whole field of hygiene is covered in the first place, by 12 principal groups (divided into 44 smaller groups) of exhibits of purely scientific interest, each of which has its own building or sharply defined part of a building With each of these groups is associated in the same building if possible the corresponding group of industrial exhibits

Separate from all of these is the historical and ethnographic section which serves as an introduction to the whole subject of hygiene and illustrates the hygiene usages of civilized and uncivilized races of all periods and countries Another building is devoted to the popular section, which is designed to impart elementary notions of human anatomy physiology and hygiene, to show the purpose and operation of sanitary regulations and to overcome popular prejudice against disinfection, quarantine vaccination and other necessary hygienic precautions

Finally there is a section of exercise and sport containing athletic and gymnastic apparatus of every sort together with a scientific demonstration of the effects of various exercises on the body

The buildings of the exposition are constructed and assigned in accordance with this general plan Separate buildings are provided for the sections *House and Home*, *Food* *Clothing and Care of the Body* ' *Traffic*, *Nursing and Life Saving* *Army and Navy* *Hygiene of Childhood and Youth* and *Baths and Water Cures* The eastern part of the main building is assigned to the historical and ethnographic section and the western part to infectious disease and allied subjects with which no industrial exhibits are associated A special building is provided for the sub-section of chemistry and scientific instruments The section Exercise and Sport includes a large stadium a scientific collection and a laboratory in which experimental researches on the effect of exercise will be made Olympian games football tennis wrestling military drills golf fencing pool rifle shooting horse racing rowing and motor boat automobile airship and aeroplane contests are some of the sports that will be represented this summer at Dresden in connection with the International Hygiene Exposition

The buildings of the exposition designed by twenty one leading architects of Dresden are singularly dignified appropriate and harmonious in style Most of them are built of wood but in order to minimize the danger of fire they are completely covered and lined with plaster stucco and fire-proofed fabrics The architects unanimously agreed that the buildings should appear to be exactly what they are—temporary structures designed for a special purpose and should not be fantastic monumental creations or pompous imitations in wood and plaster of historical stone palaces and temples.

The buildings are for the most part of one story with side walls about 13 feet high The wider halls have a higher central wave with a clerestory for the illumination of the central part Wide aisles unobstructed vistas and abundant side light are found in all of the buildings Simplicity and repose are the keynotes of the interior architecture the idea is to present the exhibits clearly and not to distract attention from them by impertinent ornamentation Outwardly the buildings are equally simple they produce their pleasing and harmonious effect by the distribution of masses and by a sound and simple color scheme The walls are covered chiefly with a coarse grained stucco painted white which is diversified by a few colored lines and simple ornaments in relief The roofs are brightly tinted with colors harmonizing with the green foliage of the fine old trees which surround them The buildings cover about 18 of the 80 acres occupied by the exposition

In connection with the exposition courses of lectures on various branches of hygiene will be given and a number of congresses will be held under the auspices of various scientific technical industrial charitable and athletic associations

The Oldest Steam Threshing Engine

Thirty Years of Service

By H A Steven

Of all the threshing engines in use to-day in the world the oldest is located within four miles north west of Wheaton Ill For over thirty years this iron horse has done its work outliving any traction engine and is in as good condition as the day it came from the shops of the Aultman Company of Ohio When it was purchased the owner Mr A G Ransom reasoned that a perpendicular engine would not wear out as soon as the horizontal type mostly in use and the result seems to have confirmed his view While the present boiler is the second one used and a new set of flues has been put in still the engine does not look the worse for wear

The first test of this well taken-care-of engine was in the threshing on my father s farm of oats which were dry and in the best condition On the morning in question in 1880 it started its work with a steady even motion and the grain was sent through a separator propelled by this old timer until evening when it was found that the outfit had threshed out 2 750 bushels for the day s run This is the world s record for oats threshed in one working day by a 10 horse-power mechanical contrivance To be sure there were no elevators or blowers or self feeders on threshing machines at that period but even with the aid of modern accessories operators in the business to-day would be glad to average 2 750 bushels of oats with their 25 horse-power engines and 60 inch separators

There are three facts that must be admitted First The average threshing outfit has not lasted fifteen years Second The perpendicular engine will outlast any of the horizontal type Third In spite of theorists and book learned engineers the owner of this engine is the most practical engineer a statement which I can substantiate by ample proofs

He levels the separator and the engine with his eye using the horizon and not a level It takes him five minutes to set the machine and if a pulley is squeaking on the running separator he can tell which one of the former it is before it makes six revolutions This almost instinctive knowledge may account in a great measure for the long life of the engine and its extraordinary capacity for work as shown in what is probably another record viz the greatest amount of grain threshed by any one apparatus during a continuous period of thirty years

The speed maintained during all these years for the cylinder on the threshing machine has been about 1,150 revolutions per minute, which partially explains why the wear and tear is so slight. At this speed the separator will stop before it is torn to pieces on wet grain, stones pieces of iron, etc. The perpendicular pulsations or vibrations give a perfectly steady motion on the large belt. This, of course tends to prevent the wearing out of the bearings and the working loose of the nuts.

In traveling up and down hill along highways, the water in the boiler has never left the part around the firebox, a condition which invites melting of the [illegible], and in some instances the explosion of the [illegible]. When a horizontal boiler is moved forward down hill the water rushes ahead and leaves the firebox bare save for the dry steam which latter will not prevent melting This partly accounts for the long life of the two boilers used in this case

THE OLDEST STEAM THRESHING ENGINE, STILL IN CONSTANT SERVICE

Carrying out the erroneous idea of housing engines when they are not in use causes many engineers to be particular in this direction but most negligent in others This one was never put under shelter but the essential parts were always coated with grease and when the owner got through at the end of the season he always lubricated the cylinder

The modern method of feeding a thresher is most unscientific. Thoughtless youths and men eager to get through throw in six or seven bundles at a time and expect the cylinder, fanning mill and elevators to do good work This cannot be done and as much time is lost as is gained by hurrying in this manner

The last large belt from the engine to the separator is made of canvas, and has lasted twenty years, and in reference to this phase of the work Mr Ransom claims that rubber belts will last still longer when not exposed to the wet.

On warm days he uses from 1,000 to 1,200 pounds of soft coal, while in cold weather he burns from 1,200 to 1,400 pounds. The steam carried ranges from 80 to 100 pounds.

The team of horses used to guide the engine partly removes the danger of runaways along the public highways.

This engineer has a gasoline engine for use in churning pumping etc which was purchased from the Fairbanks & Morse Company twelve years ago and it is just as good as new How does he manage it? is the question He claims that the average engineer does not think or does not care about machinery that the average man running an engine is not a natural mechanic nor does he school himself to take care of everything and that the machinery will break and then the engineer will blame the manufacturer when the absent minded or negligent operator is the cause We seldom find all of the following qualities in one person that Mr Ransom possesses namely a good carpenter having built house shop and barn for himself and for others a successful well digger having sunk over 150 wells an excellent blacksmith and wagon maker a good farmer having averaged over 40 bushels of oats per acre and over 60 bushels of corn per acre for the last twenty years and withal a broad minded and well read man on many subjects His theory on the use of galvanized pipe in the ground is worth considering the automatic float which he uses is highly interesting

This engine so ably run and so carefully preserved by its original and only handler is indeed an object of interest as viewed in the illustration and the record herewith of its performances and the lessons handed down by the practical owner should appeal to all young men who may aspire to become engineers and who may wish to take care of all kinds of machinery

The Gutta-percha Tree

On account of the extreme usefulness of gutta percha in constructing submarine cables every effort is being made to save the tree that yields the valuable gum from destruction No satisfactory substitute for gutta percha found in the forests of the Malay Peninsula and in Malacca has been discovered but the natives in order to get quick returns are destroying the trees so rapidly that a gutta percha famine is feared To prevent this the French Dutch and British governments are striving not only to prevent the waste of the trees already existing but to increase their number by transplantation and cultivation Experiments with transplanted trees are being made in Reunion and Madagascar

To Produce Nitrogen (According to Tichborne) — In a retort of sufficient capacity (about 1½ liters) place 10 parts (grammes) of sulphate of ammonia 10 parts (grammes) nitrite of sodium 40 parts (grammes) of glycerine and 60 parts (cubic centimeters) of water Incline the neck of the retort rather sharply upward, so that the condensed water will drain back into the retort and heat it. The generation of gas commences at about 90 deg C (194 deg. F) and continues, at moderate heat steadily, until the nitrite is completely reduced.

An Air Propeller Testing Apparatus

Professor Prandtl's System

THE following description and the accompanying il lustrations deal with an air propeller testing appar atus described by Paul de Jeuhr in the *Zeitschrift für Flugtechnik und Motorluftschiffahrt*

Most aeroplane propeller testing plants are wrongly conceived because the conditions are not similar to those of an aeroplane in flight Hence the results ob

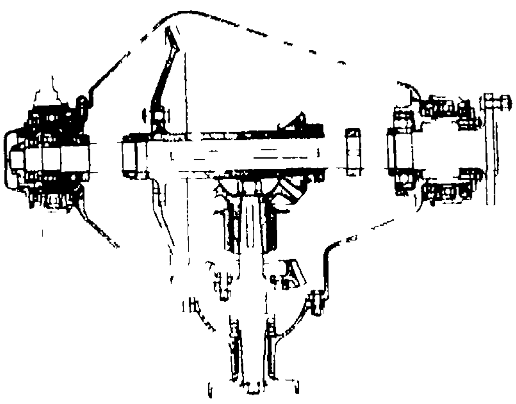


FIG 1—PROPELLER DRIVING GEAR UPPER PORTION

tained cannot be directly applied to the flying machine without due allowance for many factors of error Prof Prandtl of the University of Goettingen was in trusted with the task of devising an entirely new type of propeller testing apparatus which would be free from any of the objections to which the stationary testing plant is open This design was intended to furnish the following data

1 The altitude of the apparatus was to be suf ficiently large to measure propellors of great size and high speed

2 The propellers were to be tested under con ditions as similar as possible to those which ob tained in a flying machine

3 The apparatus was to be so constructed that it

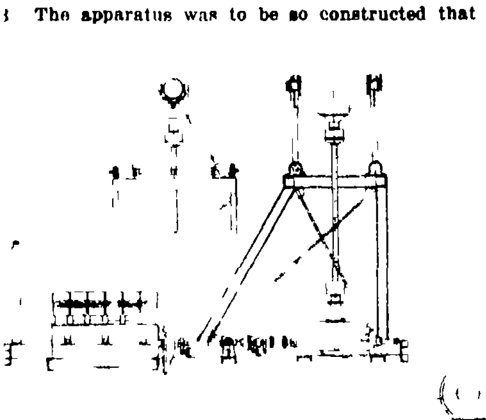


FIG 2—SIDE ELEVATION OF PROPELLER-TEST ING CAR AND VIEW OF UPPER PORTION (END ELEVATION)

could easily be transformed into a stationary testing plant if necessary

The first condition was satisfied largely by cor respondence with firms engaged in the construction of airships and flying machines From this cor respondence it followed that the largest possible pro peller to be tested would have a diameter of about 5 meters and that the propeller shaft in every direction would deliver about 60 horse-power when revolving at speeds of 200 to 1 200 revolutions per minute

At first it was thought that a small boat such as the Zeppelin company originally used for the testing of its propellers might be available It was finally de cided however that it would be better for all pur poses to have a machine which could be used on land Naturally some form of structure which traveled on rails suggested itself This in turn gave rise to the first difficulty the constantly changing direction of the wind and its influence upon the results obtained This difficulty was overcome without a single acci dent by laying the track in the general direction of the wind and by limiting tests to lateral winds which blew at an angle of not more than 20 degrees

The front end of the car should offer as little re sistance to the air as possible and especially avoid the creation of eddies To this end it is found best to employ a buoy shaped casing for the driving gear since a smooth passage of the air in the vicinity of the propeller is particularly desirable

The wide variation in the dimensions of the screws

FIG 3—DRIVER S SEAT AND INSTRUMENTS

At the right of the seat is a lever for throwing in the trans mission to the left is a lever controlling the motor a pedal controls a friction clutch In front of the driver s seat are the frequency meter tachometer and manometer On the table in the background are the contact clock special circuit breakers, and a chronograph

tested caused another factor—the smooth running of the car—to assume importance and this in its turn led to the endeavor to make the car as light as possible

To be prepared for all contingencies the rims of the wheels were made suitable for the rails either of standard gage railroads or tramways

The wire-spoked wheels of 500 millimeters diam eter with reinforced tire, are fixed on the axles, and turn with them in triple ball bearings which permit at the same time a certain play of the axles

The casing of the ball bearings is suspended in a cast steel hanger between two spiral springs and this hanger also serves as a support for the angle lever of the unusually powerful internal expanding brake

The brake worked by a hand lever from the driver s seat has two shoes inside the rim of each wheel The driver s lever transmits the power through a shaft to a rod fixed beneath the two longitudinal girders and this in turn acts on the two wheels of one side Since the wheels of each axle are firmly at tached to it, this gives a double security

The frame of the car consists of four pressed-steel girders 100 × 40 × 4 millimeters in size, strengthened by two diagonal struts.

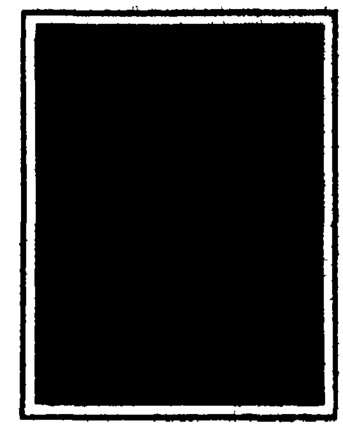


FIG 4—THE PROPELLER CASING

The octagonal sand packed walls of the propeller space are visible as well as the open straw packed doors.

On this light frame the essential part of the driving machinery is mounted This has proven advisable on account of the very considerable vibration. The parts consist of a 100 horse-power motor with normal speed of 1 800 revolutions per minute propellers from the smallest up to 5 meters diameter and cap able of making 200 to 1 200 revolutions per minute. The direction of rotation of the propellers may be

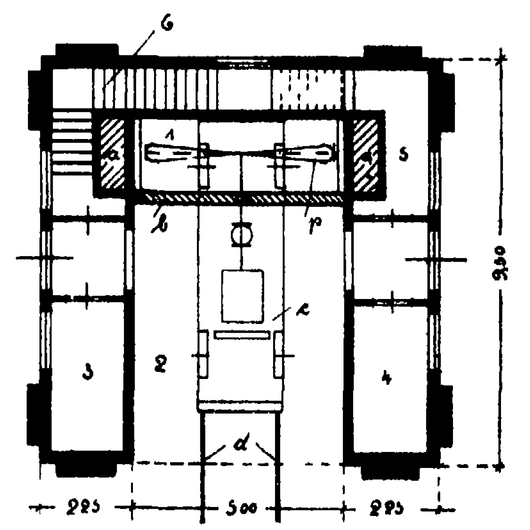
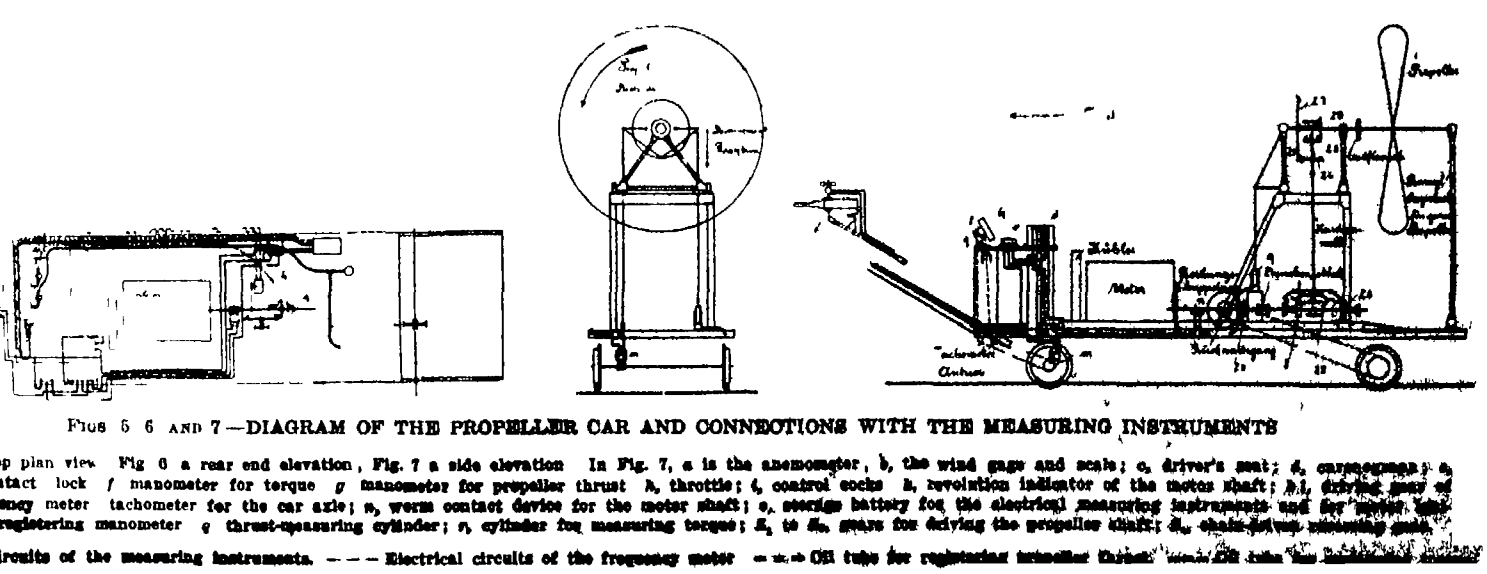


FIG 8—PLAN VIEW OF THE PROPELLER FRAME

1 Propeller casing *a* sand packing *b* double wooden up rights with straw packing 2 car and observation space *c* testing car *d*, propeller to be tested *e*, tracks for the car 3, space for instruments 4 driver s station 5 tool house 6 staircase

either right or left.

The original idea of a planetary reversible drive was dropped because on account of the enormous power too much noise would have been made and the wear would have been too rapid Furthermore



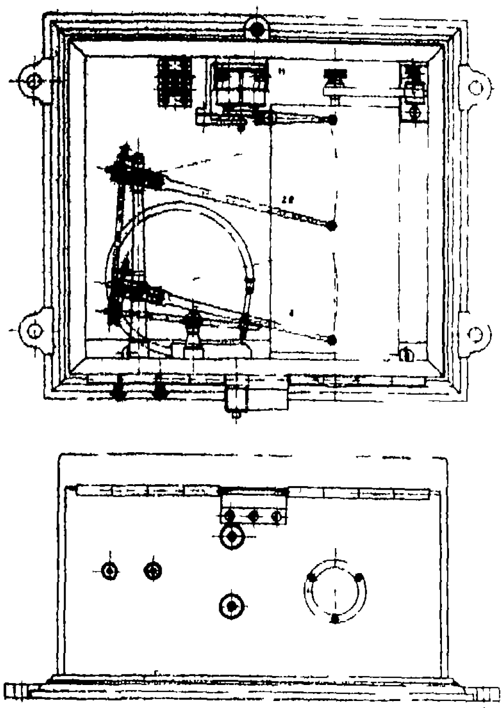
FIGS 5 6 AND 7—DIAGRAM OF THE PROPELLER CAR AND CONNECTIONS WITH THE MEASURING INSTRUMENTS

Fig 5 is a top plan view Fig 6 a rear end elevation, Fig. 7 a side elevation In Fig. 7, *a* is the anemometer, *b*, the wind gage and scale; *c*, driver's seat; *d*, [illegible] *e*, second-contact lock *f* manometer for torque *g* manometer for propeller thrust *h*, throttle; *i*, control cocks *k*, revolution indicator of the motor shaft; *l*, driving gear of the frequency meter tachometer for the car axle; *n*, worm contact device for the motor shaft; *o*, storage battery for the electrical measuring instruments and [illegible] tion *p*, registering manometer *q* thrust-measuring cylinder; *r*, cylinder for measuring torque; Z_1 to Z_6, gears for driving the propeller shaft; [illegible]

—— Electrical circuits of the measuring instruments. – – – Electrical circuits of the frequency meter – × – Oil tube for registering propeller thrust [illegible]

[illegible] the change in the number of revolutions be[illegible] certain limits scarcely came with any one pro[illegible] and was not great enough to be important.

By the reversing of the propeller itself a more ef[illegible] drive was obtainable, so that this slight in[illegible]convenience was offset by decided advantages



FIGS 9 AND 10—DOUBLE RECORDING MANOMETER

Side elevation and bottom plan view r^1 (r^2 behind it) tubular springs s^1 indicator or writing lever of the torque manometer s^2 of the thrust indicator s^3 writing lever for recording time actuated by the armature a of the magnet m.

Even in the testing of many different propellers as is customarily the case in prize competitions, a certain grouping is possible so that a change of gear is necessary only after the testing of the group

As the greatest propeller thrust was taken as 300 kilogrammes the greatest turning moment demanded was 300 kilogramme meters on the propeller shaft if the construction was carried out on the basis of this valuation

The motor and propeller shafts located at different levels were connected through two sets of bevel gears and a vertical shaft.

The four changes of speed desired made necessary double sets of bevel gears while still another pair of bevel gears on the engine shaft made possible the rotation of the vertical and hence of the propeller shaft in either direction so that either right or left hand propellers can be tested In the upper casing a large and a small set of bevel gears were arranged while a second set mounted on the engine shaft on the opposite side of the vertical shaft served to give the reverse

The reversal above is effected by sliding bevel gears on the vertical shaft upon which they are mounted on a feather The four bevel gears on the horizontal engine shaft extension are secured to the shaft The lowermost bevel of the vertical shaft and the hub of the upper wheel (which extends into a socket) are fixed upon the shaft in their positions

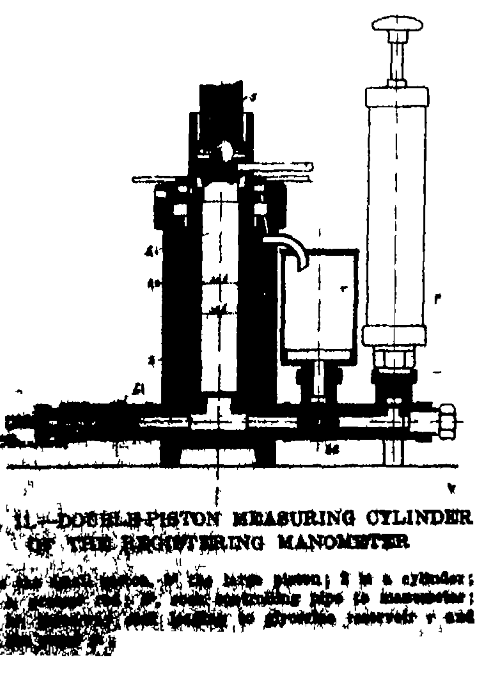


FIG. 11—DOUBLE-PISTON MEASURING CYLINDER OF THE REGISTERING MANOMETER

[illegible] the large piston; Z is a cylinder; [illegible] connecting pipe to manometer; [illegible] reservoir r and [illegible]

When now the lower gear is in action the annular toothed ring forming the upper gear is drawn up out of the way and fastened to the top of the casing, if on the other hand the exterior gear is brought into action, then this ring is fastened to its (Nabe) by a jaw clutch

In any case the horizontal shaft with its gears is displaced and united with the motor shaft by a suitable connection

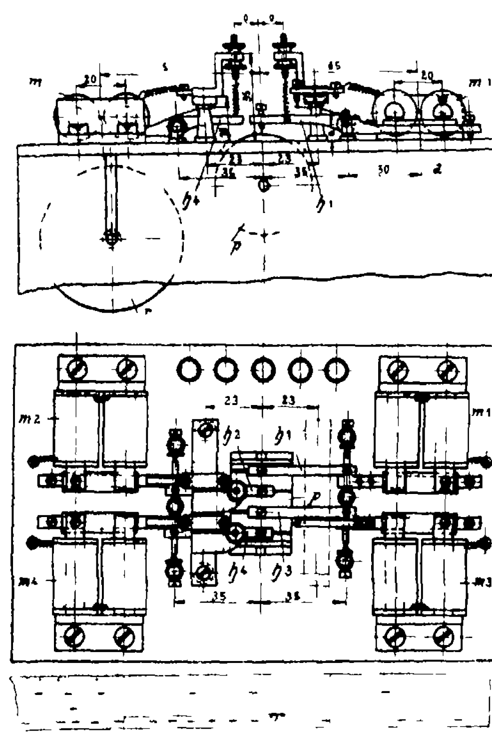
The cast aluminium casings are tightly closed so that the gears can run immersed in the lubricant The upper propeller shaft runs in ball bearings the thrust of the bevel gears being taken up by ball thrust bearings (Kugel stützlager) All other bearings are of bronze with large surfaces

The gears and their shafts are made of chrome nickel steel which accounts for the small dimensions possible in spite of the severe strain caused by the sudden shocks.

The parts just described serve another purpose i e they make possible the measurement of two things of importance namely the thrust and the turning moment necessary to drive them

This is best explained by the diagram On the trapezium formed base to which a frame is firmly fastened a parallelogram is movably carried by the propeller shaft If the screw gives an outward thrust the parallelogram has the tendency to tip toward the front in which movement it is hindered by the angle lever with the presser rod

The vertical pressure of this rod will therefore stand a definite relation to the propeller thrust The parallelogram which is of triangular cross section for the prevention of a side movement now carries on the propeller shaft the whole upper casing the verti



FIGS 12 AND 13 -CHRONOGRAPH

Side elevation and top plan view m_1 electromagnet for actuating the writing lever h of the second contact clock m with h^2 for the anemometer m^3 with h^3 for the car velocity m^4 with h^4 for the motor revolutions r paper drum p paper roll

cal shaft with its two universal joints permitting a marked oscillation of this casing

If now the propeller is driven the reaction of its torque retards its driving bevel wheel and causes the opposite wheel of the vetical shaft to roll off upon it

This motion vertical to the plane of the propeller shaft is transmitted through the bearing to the casing which would now shift outwardly if it were not held by a suitable rod

Through this simple arrangement the thrust and the torque can be estimated directly from the driving shaft without the necessity of allowing for lateral effects such as friction etc On this account also the suspension of the upper casing is so carefully carried out with many ball bearings while in general the upper shaft merely has one ball bearing

Even the bearings of the parallelogram used only when it tips, are provided with balls on account of the weight they carry The forward strut of the frame has an extension toward the front in order to distribute the propeller thrust well to the frame and thence to the under structure

The end flange of the upper shaft is furnished with a boss; every propeller to be tested must have a flange. In order to test with safety heavy or large air propellers without straining the bearings, there is provided a removable brace made of steel tubes with binding in pieces whose interiors move in two grooves in the direction of the length of the car in order to place a screw in each axle length

The essential position of the propeller shaft in this frame which can also be adjusted or displaced by different barrels of 25 to 70 diameter consists of a ball bearing which by means of two lateral pins can swing in turn in ball bearings

A movement forward relatively to the car occasioned by the thrust of the screw will therefore

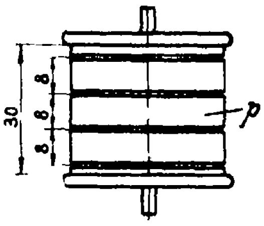


FIG 14—THE PAPER ROLL P

not be hindered except by the presser rod provided for that purpose

A rearward tipping of the parallelogram is avoided by a stop with an adjustable screw while a movement out of the upper casing toward the side opposite to the presser rod is prevented by the construction of a steel tube provided with a rubber buffer

The motor is provided with an ordinary leather friction clutch Moreover a claw clutch is built into the shaft in order to permit safe testing of the propeller with a running motor

Because the tests are made on straight tracks, and because the screws drive the car in only one direc-

FIG 16

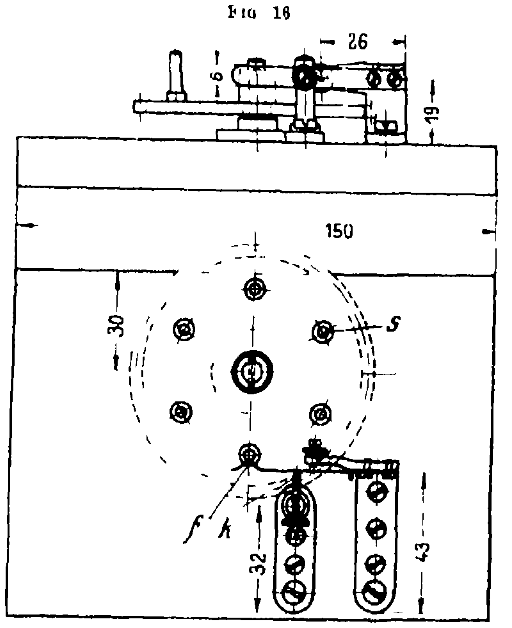


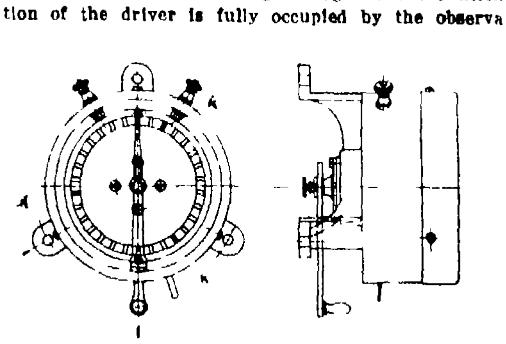
FIG 15

FIGS 15 AND 16—ELECTRICAL CONTACT APPARATUS FOR REGISTERING THE CAR SPEED AND THE MOTOR SPEED

Side elevation and bottom plan view s pins on the worm wheel f contact spring k contact screw

tion a special method of driving the motor must be provided for the return journey For this purpose a small bevel gear is placed on the intermediate shaft displaceably which by means of a larger and a smaller chain gear drives the rear axle directly after the whole propeller gear is thrown out by means of the chain clutch

Passing to the consideration of the measuring instruments it is obvious that the chief desideratum is that they should be self registering since the attention of the driver is fully occupied by the observa



FIGS 17 AND 18—SECOND-CONTACT CLOCK

Side elevation and top plan view k are the contacts for indicating the time at the recording manometer (Fig 7 a).

tion of the course and the attainment and maintenance of a certain uniformity of operation Therefore electric indicators are preferred except for the thrust and the revolutions

As we have seen the propeller thrust and the revolutions of the same are indicated by the pressure on a vertical rod For the automatic recording an hydraulic transmission was chosen and this connected with a double registering manometer

Under each recording lever is firmly fixed a measuring cylinder of chrome nickel steel in which are fitted two smoothly polished pistons These two pistons serve to give different ranges for small and large propellers The manometer registers up to 25 kilogrammes per square centimeter the small piston of 3 centimeters diameter suffices therefore for a rod pressure up to 170 kilogrammes while the larger of 6 centimeters diameter can absorb as high as 600 kilogrammes

When the small piston moves through the pumping in of a fluid (glycerine) the large piston must be forced up till it rests against the cover Consequently the small piston must vary from the large one by 1 to 2 centimeters

On the other hand if oil glycerine is allowed to flow out of the pump till the small piston rests upon the large then the whole cross section is thrown into operation

The connection with the presser rod is effected by a polished ball which lies between two ball pockets which are on the other hand loosely centered by a cover

Because of the different directions of revolution of the screw the measuring cylinder for the torque must be reversible tubing lies on either side (see diagram)

The pressure transmission leads the cylinders to two ordinary stop cocks whose purpose is to check chance shocks in the tube transmission and keep them from affecting the manometers

For this purpose the slits of the cock are soldered up the valve itself however can be pressed against the cone or withdrawn depending on the amount of the throttling

From this point the piping leads to two flat spring manometers with indicators which are gaged or standardized up to the double pressure of the registering manometer 30 kilogrammes per square centimeter

The control cocks lying behind these manometers are not opened until the indicator manometers show that the permissible pressure is not exceeded as for instance might happen by accidentally moving the small piston which might injure the delicate registering manometers

These instruments are placed behind the car since this is the place of least vibration a position not completely satisfactory because here the recording is difficult

The clockwork of the recording drum causes it to revolve once in 2 minutes if we reckon 10 seconds for the duration of the trip then there are a sufficient number of conditions united on one strip if it is put on and taken off at the right time

The second apparatus is the chronograph Clock work moves a strip of paper over a drum at a rate of about 13 meter-seconds beneath four writing levers operated by electromagnets Needles serve as stylo cutting a hole in the paper when the current is closed when the current is closed for a longer time a series of holes is made since the levers are provided with current interrupters as in the case of electric bells Thus tearing of the paper is avoided The indentations of the needles can be easily read on the reverse side of the paper

This chronograph is operated in the following manner On the intermediate shaft behind the motor a small worm is mounted meshing with a small worm wheel In this worm wheel two diametrically opposed pencils are carried which by means of a small spring close the current at every passing The worm has but one entrance the wheel has thirty teeth therefore with two pencils there is a contact after every fifteen revolutions of the motor this contact being indicated by the pencil as a point on the paper strip In a similar manner the revolutions of the front axle are recorded from which the speed of the car is found but here up to six pencils may have to be screwed in according to the expected speed so that a sufficient number of effective contacts may be obtained

Thirdly the relative speed of the propeller to the wind to be obtained For this purpose the car is lengthened at the front end by a mast five meters long to whose point is attached a wind vane with a Robinson's anemometer above it

The wind vane moves on two ball bearings and serves the purpose of reading during the journey from the scale the deviation caused by the side wind

The anemometer whose buckets lie at a distance of almost 16 inches from the screw on the lengthened propeller axle so that the suction may exert no influence on it (as experience has shown) is so arranged that it gives a contact after every twenty meters of its passage through the air making a dot on the paper (Fig 14)

Finally comes the important comparative instrument whose records determine the measure of time, the *second-contact-clock* (Figs 17 and 18) The revolving pointer makes and breaks the contacts as these are rather long a short row of dots is made instead of one dot

But the importance of the clock depends on another device (see diagram) Every tenth contact is separated from the others and leads the current in stead of to the chronograph, to an indicator of the registering manometer therefore there is a gap on the chronograph whenever a record is made on the manometer Consequently in synchronously arranged instruments the speed belonging to a given thrust and moment of revolution is unfailingly indicated when the diagram is superposed that the second marks of the manometer bulletin fill out the gap of the chronograph diagram

The meaning of the diagrams can be seen in Figs 9 and 14 which do not however belong together but merely serve as examples

First the strips of the chronograph In the upper row we see the regular time contacts of the clock after every nine dashes a gap for the tenth second Underneath the records of the anemometer the cam axle and the motor shaft For reckoning a vertical

FIG 19—END VIEW OF THE PROPELLER TESTING CAR

line is drawn every 10 seconds and merely the points lying between are counted (In case of irregularities a correspondingly greater time interval must be chosen) Then we find in our example a speed of the propeller against the air of 3 33 points in 10 seconds i e 0 333 in 1 second therefore 20 0 333 = 6 66 meter-seconds To this is added the anemometer correction which for this reading equals 1 004, so that the virtual speed reckoned at 6 69 meter seconds the speed of the car is reckoned according to the following formula The contact given on the car axle had three pencils with thirty teeth and a worm with one entrance therefore each contact signifies ten revolutions of the wheel which on the other hand with a 500 diameter = 15 28 meters 6 25 points in 10 seconds 0 625 in 1 second corresponding then to a car speed of 9 55 meter-seconds According to the foregoing the diagram gives finally 11 15 6 = 990 revolutions per minute for the motor from which can be estimated the revolutions of the propeller

Next the manometer bulletin The points *A* will therefore correspond constantly to a gap in the time marks on the chronograph and it is necessary to mark exactly on both only the beginning of the experiment The upper thrust curve is described when the large piston is working therefore every kilogramme-centimeter[2] of pressure corresponds to the cross section $\frac{6^2\pi}{4}$ = 28 3 kilogrammes in the designated case therefore = 9 1 28 3 = 257 kilogrammes.

But now by means of the angle lever, the thrusting of the propeller is transmitted to the rod in the relation 2 1, therefore a virtual thrust is found of $\frac{257}{2}$ = 128.5 kilogrammes. The moment of revolution transmits itself to the presser rod by a lever arm of [illegible] meter therefore corresponds to the pressure of (for example) 5 7 kilogramme-centimeters, in a cross section of the small piston of $\frac{3^2\pi}{4}$ = 7 07 centimeters,

5 7 7 07 0 05 = 20 15 meter-kilogrammes.

There are also two instruments of importance for the guiding of the car—a tachometer for its speed, and a frequency meter for the number of revolutions of the motor The first, a simple speed pendulum with a revolving indicator, is driven through belts by the forward axle and gives the speed of the car in second meters.

The frequency meter depends on the resonance principle the exciter being driven through belts by the motor shaft, and connected with the revolution indicator

These two devices and the indicating manometer are placed directly in front of the driver the other instruments also are fastened to the table in front (see diagram)

Further here are found at the left of the driver's seat the levers regulating the sparking and mixing for the motor, a foot lever operates the friction clutch a large lever forward is for use in handling the brake another to the right is used for the governing of the claw clutch, and finally somewhat to the rear lies the lever for reversing

The motor is turned forward by which the inertia of the car is quickly overcome Close by the motor is the seat for the observer who always goes along on the trip

The trial trips are conducted in the following manner After the clutch of the gear intended for the propeller is thrown in the meter transmissions and testing instruments are started the car is firmly braked the motor set going the gear with the claw clutch thrown in and the friction clutch on the motor slowly put in by means of the foot lever After the propeller (with the car not moving) has been brought to the right number of revolutions by the sparking and manipulating levers the brake is removed and the car comes very quickly to the required speed As soon as a certain uniformity is observed in the number of revolutions as well as in the indicating manometer by means of drawing cords, the measuring instruments are put in operation simultaneously Then the circuit is closed by a small governor in front of the driver's seat, while the driver tries to hold the speed constant by the regulation of the motor or use of the brake As soon as a record is made it is best seen by the striking of the time indicator on the registering manometer The instruments are then stopped and if the distance seems long enough another speed is taken and a second observation is made

PRELIMINARY RESULTS OF EXPERIMENTS WITH THE APPARATUS FOR TESTING AERIAL PROPELLERS

The tests of aerial propellers made with the apparatus constructed for the first international aeronautic exhibition are now completed The results will shortly be published in detail A brief summary of the results and the entries is given below

The long postponement of the final tests was caused through delay in the construction of the apparatus by an accident which necessitated extensive repairs and finally by the long practice which was required in order to secure perfectly harmonious action of the numerous instruments and the assistants in their operation

In January 1910 in a large hall in Frankfort, tests were made of the propellers which had been entered in competition for the prizes offered by the Prussian war department for propellers of German manufacture only

This competition was subject to the following conditions

1 Only propellers of uniform pitch were admitted

2 The tests were made at a fixed point the quantities measured being the tractive effort, the consumption of power and the number of revolutions per minute

3 The propellers were divided into two groups The first group included airship propellers not exceeding 5 meters (16.4 feet) in diameter, which were required to develop a tractive effort of 300 kilogrammes (661 pounds) at a fixed point The second group included propellers not exceeding 3 meters (9.8 feet) in diameter which were required to develop a tractive effort of 150 kilogrammes (330,7 pounds)

4. All propellers were excluded in which the product of the pitch multiplied by the number of revolutions per second required to develop the prescribed tractive effort, was less than 15 meters (49.2 feet) because the tractive effort of such propellers would vanish at a speed of 15 meters per second and the propellers would be unable to produce any useful tractive effort at the speeds required in practice.

5. A prize of 3,000 marks ($714) subject to deduction was offered in each group

6. Each propeller must be accompanied by a statement of its pitch and the maximum number of revolutions for which it was designed

7. The prizes were awarded for the smallest values of the product $N^3 r G$ in which N^3 denotes the number of horse-power consumed r the greatest radius and G the total weight of the propeller

The propellers originally entered for this competition numbered forty-eight, and eight others were subsequently sent as substitutes for propellers which had been broken making the total number fifty six. Two propellers of foreign make were excluded by the conditions of this national competition three were rejected because their weight or construction made it impossible to test them with the apparatus provided many failed to pass the test of strength applied by the centrifugal machine or broke during the final test before sufficient data had been obtained and finally the requirement of uniform pitch restricted the competition to nine propellers two of group I and seven of group II Details concerning the five propellers which made the best records are given in the following table, in which weights are expressed in kilograms and lengths in meters

Group	Required Tractive Effort	Radius r	Horse-power N	Weight G	Product $N^3 r G$	Prize	Name of Exhibitor
II	150	1 05	80 3	6 55	10 020	First	Reissner
II	150	1 18	88 5	12 5	20 900	Second	Gross
II	150	1 50	84 2	30 0	105 100		Ruthenberg
I	800	2 50	56 0	84 0	533 000	First	Ruthenberg
I	800	2 50	54 6	99 9	1 475 000	Second	Rettig

Translator's Note The third fourth and fifth members in the column marked Product appear to be about twice as large as they should be in order to correspond with the numbers in the preceding columns

FIG 20—GENERAL VIEW OF THE PROPELLER TESTING CAR

In the competition organized by the International Aeronautic Exhibition three qualities were recognized and two prizes were offered for excellence in each. These qualities were

1 Efficiency $\eta = \frac{P\,v}{M\,\omega}$

2 Economy of space $\zeta = \eta \left(\frac{1}{2} + \sqrt{\frac{1}{4} + \frac{\varphi}{2}}\right)$

where: $\varphi = \frac{P\,g}{\gamma\,\pi\,r^2\,v^2}$

3. Suitability for work at high speeds

$$\vartheta = \frac{P^3}{M^2\,\omega}\sqrt{\frac{r\,g}{\gamma}}$$

In these formulæ P denotes the thrust of the propeller, M the applied torque, r the radius of the propeller, v the velocity of the center of the propeller relatively to the velocity of the air current ω the angular velocity of the propeller γ the weight of a unit volume of air, and g the acceleration due to gravity. The values of η, ζ and ϑ calculated from the experiments were plotted as ordinates to the values of $\lambda = \frac{v}{r\omega}$ as abscissas, and curves were drawn through the points thus established. The prizes were given for the maximum ordinates of the curve or in case these maxima were not attained in the experiments for the highest measured points. The formulæ experimental results and curves will be discussed in a future article.

Of the 56 propellers four were rejected because they could not be tested with the apparatus three were withdrawn before the commencement of the experiments and seven were broken in testing The prize winners and the several groups are given in the following table

Exhibitor	Number of Blades	Radius r	Thrust P	Torque M	v	ω	η	ζ	ϑ	Prize
Group 1 Efficiency η										
Reissner	2	1 5	45 9	28 28	18 14	30 9	0 896			1
Rettig	4	2 5	16 0	152 00	16 27	23 2	0 70			2
Group 2 Economy of Space ζ										
Reissner	2	1 5	45 9	28 28	18 14	30 9		0 896		1
Rettig	4	2 5	191 8	84 8	9 7	15 3		0 908		2
Group 3 Usefulness for High Speeds ϑ										
Zeise	2	1 02	113	27 5	15 58	115 2			4	1
Zeise	2	1 05	6	21 9	8 96	72 5			4 4	2

Rainfall and Parasites

THAT parasite diseases of stock are mainly due to wet and marshy pasture lands is very well brought out by M G Moussu a member of the French Agricultural Society He also shows how to remedy matters in such cases For the last few years the amount of rainfall has greatly exceeded the normal and if the year 1910 is to be counted as an exception in this regard the preceding years 1908 and 1909 had their share in preparing the economic disasters which we have felt recently The persistent dampness favors the development and spreading of spore maladies which affect vegetables and in stock raising the effect is none the less harmful The continual rains the freshets and inundations have greatly modified the aspect and the flora of meadow lands and transform the best pasturages into marshes Here the animal parasites find a very good ground for developing outside the organism and it is remarked that we find the great animal epidemics such as zootics of parasite origin to follow periods of inundation The year 1910 is one of the worst in this respect and sheep have especially suffered so that numerous flocks are disappearing for this reason In the two preceding years other parasite maladies prevailed such as affected the stomach and intestines but this year it is the parasite disease of the liver which causes the harm known as distomatose The embryos of the parasites are absorbed by the sheep as they go among marshy pastures or along overflowing streams and this is clear when we see that the malady only affects sheep which feed outside upon pasture land for most of the year Wherever the soil is dry on plateaus or arid summits the malady is not observed nor on the other hand when the animals are kept in the fold But in especially damp years such as 1910 we find it appearing in places where it is usually absent and the author explains this by the fact that the dampness favors an unusual development and spreading of parasite embryos. These the animals take into their system along with the food plants and they pass into the stomach and liver where they fix themselves and remain after the manner of parasites

In France it is the sheep which are most affected, but we find similar maladies among young animals of the bovine race in other countries, and there are regions where even wild animals such as hares or else rabbits and goats die from this cause This year the parasitic infection has been so strongly marked that the progress of the malady upon the animals is much more rapid than usual so that they succumb within a short time instead of becoming anemic and pining away Owing to the fact that such epidemics are seen only at comparatively rare intervals there has not been paid the proper attention to finding a remedy for this state of affairs But we already have the observations as to the manner in which the parasites act so that it is not hard to draw some practical conclusions Since it is the dampness which is at fault the first measure is to drain the pasturages or take other measures so as to keep them as dry as possible Such expense would soon be made up by suppressing the loss of animals The second point is to improve the quality of the pasturage by processes such as sulphating and the use of chemical fertilizer during the spring for the result appears not only in the modification of the flora but also in the disappearing of a great proportion of parasites which are likely to cause maladies But even this will not be effective in such unusual cases of dampness as we find in 1910 and here we must take special precautions

In the regions which under ordinary circumstances are only slightly affected by the distomatose malady but where the conditions change much for the worse by great dampness the author recommends that the flocks should not be taken upon the pasture lands which were inundated nor even upon lands which remain permanently in a wet state Although this may be contrary to custom it seems to be the only way to mend matters and preserve the flocks so that there should be no hesitation about adopting this measure With proper care and foresight the flocks can always be fed when in the stables even with a low grade of fodder which is well prepared It is to be noted that even fodder taken from the wet lands can be very well used provided it is well dried beforehand as in this case it is no longer dangerous

Crude Oil Fuel in the French Navy

THE French navy department is taking measures toward using petroleum residues more extensively in the future for heating marine boilers owing to the advantages which are now so well recognized as coming from the oil fuel This is one of the indications which show that the question of substituting oil for coal is occupying the attention of different countries Oil is likely to be largely used in the future either for burning under boilers or for operating the new Diesel and other crude oil engines which are now being made in units of increasing size As regards the use of oil residues in the French navy the Minister of the Marine *Admiral Boué de Lapeyrère* is quite in favor of it and is now engaged in promoting a number of plans which will lead to a more extensive use of this fuel It is now recognized that it will be of great use in the navy owing to the greater speed and ease in taking fuel on board the vessels and the greater radius of action which a boat will have owing to the greater amount of fuel represented as heat giving power which can be taken in the available given space

All the new torpedo destroyers of the navy are installed for firing the boilers with mazout or petroleum residues of European origin Up to the present the French seaports were not well equipped for handling and storing the oil so that the cost per ton was very high and much more than in other leading countries The admiral is now taking measures to organize more modern methods for handling the oil in the leading French ports so that this country will be one of the foremost in this field At the military ports such as Toulon Brest and Cherbourg are now being installed great oil reservoirs in which the petroleum residues will henceforth be stored up and besides this a very complete system is being organized as the navy has purchased a steamer to be used specially for oil transport It will ship on oil at the Roumanian port of Constanza in the Mediterranean region which is one of the leading shipping centers for this product and will then bring the mazout to the French ports and fill up the reservoirs directly without the extra handling which heretofore brought up the cost to $31 per (long) ton while it will be now reduced to $13 per ton The new steamer has been named the Rhone and it gages 7 000 tons It is also of interest to note that the 26 000-ton battleships Courbet and Jean Bart of the French fleet as well as the new units which are to be constructed will be fitted with the necessary appliances so that they can burn crude oil or residues at the same time as coal making thus a combination system.

The Cocoanut Palm

Its Products and Their Uses

By Randolph I Geare

SPEAKING on excellent authority it may be said that the almost universal demand at the present time for the cocoanut palm (*Cocos nucifera*) on account of the many and varied uses of its products is un precedented An American consul writes that the world is being sought for additional supplies of co-coanuts

One of the most valuable parts of the cocoanut is the dried kernel called copra and in Germany the very recent discovery of practical methods of converting the crude copra oil into a palatable but ter has given a wonderful impetus to the business in that country Oil of the first pressing is used which is bleached with boneblack or fuller s earth The raw material contains sixty to seventy per cent of fat It is white or very light yellow and has a sweet odor This odor has to be eliminated and it is done by expressing the oil with steam The im ports of copra into Germany last year principally from the Dutch Indies British India Ceylon Mal acca Samoa and the Philippines amounted to more than 112 000 metric tons Over 9 000 tons of the but ter were imported of which about 3 000 tons were afterward exported the remainder being consumed locally

Cocoanuts are imported into England chiefly in the form of copra for the extraction of the oil The only by product resulting from crushing is used for cattle feeding and is worth from $34 to $39 a ton The best quality of copra comes from Malabar and is worth about $136 a ton

In Barcelona Spain many thousands of tons o copra are imported yearly at an average of $117 ton The oil there is used wholly in making soap

In the Philippine Islands the prospect for the co coanut industry is brighter than ever before Last year 1 658 724 piculs (a picul = 133 1/3 pounds) of copra were produced making these islands the largest producer of this staple in the world and ex celling in product Java the Straits Settlements Cey lon and the South Sea Islands The price of co coanuts in the Philippine Islands has risen greatly in recent years The reasons for this are the extensive use of its products for commercial purposes for mak ing edible fats such as palmine and the rise in price of articles now being supplanted by copra prod ucts There is also a growing demand for cocoanut oil for which millions of cocoanuts are used every day The Consul at Hongkong writes The possi

FRUIT CLUSTERS OF MATURE COCOANUT PALM COSTA RICA

bilities of the use of this nut fat should receive more attention from American manufacturers

In India the exports of cocoanuts during 1909 and 1910 as reported from the Madras Presidency amounted to more than 200 000 Of copra over 900 000 hundredweight valued at more than $4 000 000 were exported while the exportation of cocoanut oil amounted to nearly 6 500 000 gallons worth about $2,500 000

The Consul at Carlsbad, Austria recently reported that owing to the fact that the oil from cocoanuts is now being converted into comestible fats its mar-ket price has increased enormously and the world is being sought for additional supplies of cocoanuts

COCOANUT PALM AT CAJABON ALTA VER APAZ GUATEMALA

COCOANUT PALM NEAR PALMIRA CAUCA VALLEY COLUMBIA

The butter is prepared in two forms soft and in firm cakes It is said to be excellent for cooking pur poses It retails at about fourteen cents a pound

The soil and climate of Trinidad and Tobago are very favorable to cocoanut growing especially along the coasts and in interior districts which come within the influence of the salty atmosphere At present the export price of the nuts averages about $16 per thousand of copra four to five cents a pound and of the oil ninety cents a gallon The largest producer grows 5 000 000 nuts a year The shells are used as fertilizer and for road making

In Brazil there are wild cocoanut groves over 200 miles long and millions of the nuts are shipped an nually from there to the United States and Europe Cocoanut palms are largely used in Brazil to adorn the public parks and gardens They often grow 80 to 90 feet high The leaves are from 15 to 20 feet long and at their base the nuts hang in clusters of three to fifteen each

The foregoing instances are cited as a few out of the many reports which have been made recently to demonstrate the enormous proportions which this in dustry is reaching

Concerning the origin of the cocoanut palm many opinions have been expressed Prof O F Cook in an excellent paper on the History of the Cocoanut Palm in America, published in Contributions from the National Herbarium affirms that it was already widely distributed in the new world before the ar-rival of the Europeans and he believes that biologi cal evidence of the American origin of the palm is complete and adequate while De Candolle and other writers believe that the cocoanut palm was intro-duced into South America and the West Indies by European settlers and that it existed in pre-Spanish America only on the Pacific coast of the Panama re-gion This writer also affirms that it had its origin in the old world whence it was disseminated by sea. One thing is sure however that wherever it origin ally came from it is now met with in all tropical regions

Prof Cook believes that hardy varieties of the palm might be successfully cultivated in southern California and Arizona, and perhaps in some parts of Texas where flowing artesian wells of warm water may make it possible to protect small areas from frost—an important essential indeed A cocoanut in-dustry has already been established in southern Florida and one planter is reported to have recently sold his crop for $15 000

The cocoanut palm has pinnate leaves, and male and female flowers on the same tree, the female flowers at the base of each spadix It grows to a height of 60 to 100 feet, and on the cylindrical stem appear rings marking the place of former leaves. At its summit is a crown of from 16 to 20 leaves. Of the three round, black scars at one end of the shell, the largest one through which an opening is com-monly made to get out the milk, is the destined out-let of the germinating embryo, which is situated there, the kernel consisting generally of the endo-sperm destined for its nourishment.

The oil of the cocoanut is obtained by pressure of the bruised kernel, or by boiling over a slow fire, and skimming off the oil as it floats to the surface. A quart may be obtained from seven or eight cocoa-nuts It is liquid at the ordinary temperature of tropical countries, but in colder climates becomes a white, solid butter-like oil It becomes liquid about 74 deg F It can be separated by compression into a liquid portion called olein" and a more solid art termed stearin" or cocoin" which is of complex constitution The cake resulting from the pressure of the endosperm for its oil is an important cattle food

The root of the cocoanut palm possesses narcotic properties and is sometimes chewed instead of the areca nut When the stem is young its central part is sweet and edible but when old it is a mass of hard fiber The terminal bud (palm cabbage) is esteemed a delicacy and trees are often cut down for the sake of it The saccharine sap of the flower spathes before they open is a source of 'toddy and palm wine and also by distillation of the liquor arrack In the East Indies the juice is often boiled down to yield sugar (jaggery)

The dried leaves of the cocoanut palm are much used for thatch and for many other purposes as the making of mats screens baskets, etc., by plaiting the leaflets

The midribs of the leaves supply the natives of the tropical coasts with oars The wood of the lower stem is very hard takes a beautiful polish and is employed for a great variety of purposes under the name of porcupine wood" The fibrous center of old stems is made into cordage By far the most important fibrous product of the cocoanut tree is that obtained from the husk of the somewhat im mature nut If the nuts are allowed to ripen the coir which is a fiber beaten out from the external

COCOANUT PALM AT BELIZE, BRITISH HON DURAS SHOWING THE WIDER FORM OF THE LEAVES UNDER SEA LEVEL CONDITIONS

husk, is coarse and brittle. The husk of the ripe nut is used for fuel and also, when cut across, for polish-ing furniture, scrubbing floors, etc The shell of the cocoanut is made into cups, goblets, ladles, etc., and is often finely polished and elaborately ornamented by carving.

From the particulars given above it will be seen that every part of the cocoanut palm has a special value.

Last year there were in all parts of the world nearly 3,150,000 acres cultivated for the cocoanut palm. The number of palms was about 280,000,000, which bore not less than 7 000 000 000 of nuts, the majority of which were consumed for food purposes where they were produced

Central and South America with the West Indies had 880,000 acres the export trade therefrom in all products of the cocoanut palm exceeding $3 000 000 in value Jamaica exports about 12,000 000 nuts a year, Trinidad, 9 000 000 while from the San Blas coast of Panama alone 6 000 000 nuts are shipped annually to the United States These sell for $33 to $45 per 1,000 in the New York market and are considered to be of the finest quality produced anywhere in the world.

Both coasts of Panama are already profiting by their proximity to the Panama Canal according to Dr Charles Melville Brown who has recently made a special tour of inspection through Panama and new plantations on a much larger scale are already being set out in anticipation of the opening of the canal Favored by abundant rainfall equable climate sea breezes from both oceans with an artery of transportation to feed all parts of the world passing directly through it, and with its already established reputation for the quality of the cocoanut which that region produces Panama presents in Mr Brown s opinion a fertile field for the development of the cocoanut industry within the next few years Its west coast he remarks does not suffer from the hurricanes that sweep over the West Indies its markets are up and down both coasts and it is favored

COCOANUT PALMS AT SALAMA GUATEMALA AT AN ALTITUDE OF NEARLY 3 000 FEET

with abundant water transportation which is an important factor in cocoanut cultivation

These facts might well be carefully digested by the vast army of young men seeking profitable employment.

In starting a cocoanut plantation the first step necessary after acquiring a suitable tract of land is the selection of proper seed nuts from which the young palms are to be grown After they are six months old, clearing and transplanting takes place though some planters prefer to transplant them to a second seed bed setting them out about three feet apart and leaving them in this second bed for 12 to 18 months longer Ultimately the palms are set out at a distance of from 18 to 30 feet apart Under very favorable conditions they begin to bear fruit between the fifth and sixth years after planting and often continues to bear for 70 to 80 years The production should gradualy increase to 250 nuts a year

In the West Indies and Central America the cocoanut palm is liable to attacks of fungi as well as to a disease caused by bacteria and known as bud rot.' This disease is generally caused by the deposition of some insect's eggs in a wound in the tender stalks of the undeveloped leaves Dr Edwin Smith, of the United States Department of Agriculture, has published an exhaustive report of the subject.

The first remedial act is to destroy all diseased palms, whether they are only just beginning to be attacked or are in a dying conditions The roots should be dug out, and, with the stem leaves, burned up Lime, preferably quicklime, should be well dug into the affected spot, and the ground frequently dug over, so as to break up and aerate the soil. If necessary, the soil should be drained, the weeds on the ground should be destroyed and heavy manuring resorted to No palms should be planted in the infected spot for a year after the removal of the diseased trees.

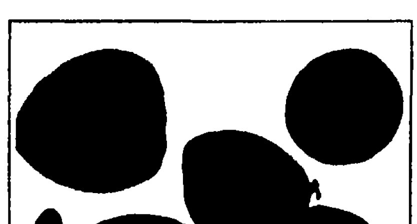
Horned beetles devour the leaves of the cocoanut palm in Samoa and other localities and the best safeguard against the ravages of insects is to plant the trees directly along the seashore within the influ

INFLORESCENCE OF THE COCOANUT PALM WITH STAMINATE AND PISTILLATE FLOWERS

ence of the salt spray The cocoanut palm is attracted by sunshine and will bend in any direction to reach it

Rats too and porcupines attack the nuts and stems of this palm respectively while wild pigs eat the tips of the young leaves

The illustrations accompanying this article have been kindly lent to me for this occasion by the Bureau of Plant Industry United States Department of Agriculture They include not only cocoanut palms but also their relative the peach palm (*Guilielma speciosa*) of Costo Rica with its fruit and seed The peach palm bears a fruit almost as large as an apricot and of a reddish yellow color It forms an important article of diet among the natives of a vast region along the eastern slopes of the Andes from Brazil and Peru through Ecuador



PEACH PALM FRUIT AND SEED

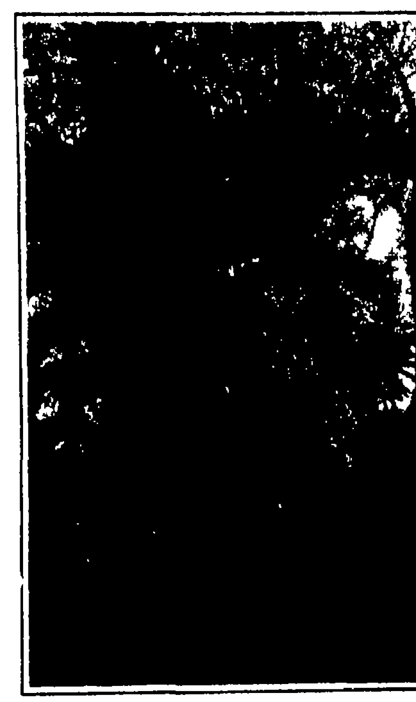
Venezuela and Colombia and beyond the Isthmus of Panama in Costa Rica

Heat from the Earth

CERTAIN scientific men now believe that the enormous internal heat of the earth may be utilized for some practical purpose Among the most distinguished scientists that hold this view may be mentioned Prof Hallock of Columbia University who is of the opinion that the plan is distinctly feasible

It is not merely a question of getting steam It is a question of the quantity of steam that can be had Near Boise Idaho hot water is now drawn from a well and used to heat a dwelling The Pittsburg and Wheeling wells are capable of heating the water left in them over night but even if their depth were sufficient to turn the water to steam it would require so many hours waiting as to rob the process of all commercial value In other words there would not be the slightest difficulty in obtaining steam from the interior of the earth because that involves only a little extra labor in boring into the hot area and it is almost as easy to bore ten thousand feet as six thousand but in order to give the steam commercial value a method must be provided for dropping the water to the hot area allowing it to heat and yet having it returned to the surface as steam without interrupting the flow

Two holes might be bored into the earth twelve thousand feet deep and perhaps fifty feet apart There would be a temperature far above the boiling point of water Then if very heavy charges of dynamite or other explosive were lowered to the bottom of each hole and exploded simultaneously a sufficient connection might be established between the two holes The rock would be cracked and fissured in all directions and shattering it thus around the base of the holes would turn the surrounding area into an immense water heater The water poured into one hole would be heated and turned into steam which would pass through the second hole to the earth s surface The pressure of such a column of steam would be enormous for aside from its initial vel



THE PEACH PALM (GUILIELMA SPECIOSA) IN COSTA RICA A RELATIVE OF THE COCOANUT

ocity the descending column of cold water would exert a pressure of at least five thousand pounds to the square inch which would drive everything movable through the second hole The problem is therefore a mechanical one concerned chiefly with connecting the two holes This accomplished the water heater would operate itself and establish a source of power that would surpass anything now in use

Disappearance of Lakes

WHETHER the globe on which we dwell is gradually drying up or not is a question that has been much debated Recent discoveries in Central Asia have been regarded by some as favoring an affirmative answer but others have replied that the observed phenomena are simply periodic changes Dr Walse of Zurich champions the affirmative view on the ground that a great number of European lakes have certainly disappeared within the last two hundred and fifty years The canton of Zurich for example had one hundred and forty nine lakes a quarter of a century ago and only seventy six to day He believes that a similar tendency to disappearance has affected the lakes of Germany and Russia

Wood stain for Canes—(a) Prepare solutions of logwood decoction 1 part of logwood in 1 part of water a solution of 0 1° part of caustic potash in 1 part of water The object is first immersed in the hot logwood decoction dried and then painted with the dilute caustic potash solution Finally place in chromate of potash (hot) (b) 250 parts of bleached shellac 400 parts of benzole and 80 parts of Venice turpentine (prime quality) dissolved in 2 000 parts of rectified alcohol and the precipitate filtered out.

Radiant Energy and Matter—III*

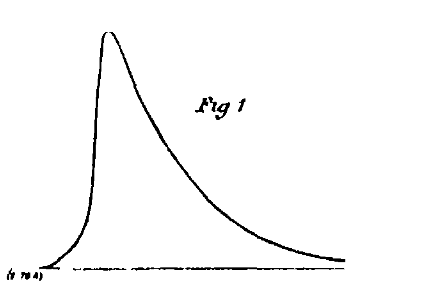
Sir J J Thomson's Royal Institution Lectures

Continued from Supplement No. 1850, page 371

In opening his third lecture at the Royal Institution Sir J J Thomson F R S said that on the last occasion he had explained that the radiometer effect constituted a very great difficulty in demonstrating the existence of a pressure due to light When light fell on a delicate vane the vane was warmed and when its temperature thus became different from that of the walls enclosing it effects were obtained due to the communication of heat from the warmed vane to molecules of the gas inside the bulb These in their turn gave up this heat to the walls of the enclosure and flying back were reheated again at the vanes and the result was that a torque was established between the system of vanes and the bulb containing them On the last occasion he had described how Prof Poynting had eliminated this effect by fixing the vanes rigidly to their mica enclosure the whole system being suspended from a quartz fibre and deflected as a whole by the light pressure falling on one of the vanes Sir James Dewar had arranged for him an experiment in which this radiometer effect was got rid of in another way Evidently since this effect arose from the presence of gas in the vessel if this gas were entirely removed the radiometer effect would disappear To make the effect negligible it was however necessary to remove practically the whole of the residual gas which was by no means an easy matter to accomplish Sir James Dewar had however prepared for him a radiometer in which the vacuum was so good that the radiometer effect was absent This was done by forming the radiometer bulb with a small narrow branch containing charcoal and immersing this stem in liquid air

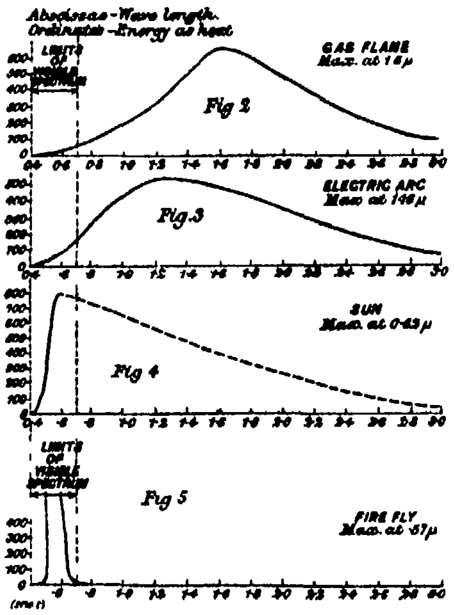
The lecturer then showed that on exposing this radiometer and an ordinary one to the same source of light the vanes in the former remained stationary while the latter spun round rapidly On next removing the vessel of liquid air from the stem already mentioned and thus allowing the charcoal to warm up the mercury vapor then liberated inside the bulb was sufficient to set the vanes in rotation while on replacing the liquid air they again came to rest as the vacuum became perfected by the condensation of the mercury vapor in the pores of the cooled charcoal A vapor pressure of less than $\frac{1}{100\,000\,000}$ of an atmosphere was the lecturer said sufficient to produce rotation of the vanes

Taking account of the existence of this light pressure it was possible he continued to prove as he had shown last week that the total amount of energy radiated from a black body must vary as θ^4 where θ denoted the absolute temperature This law he proceeded told us everything about the quantity of the radiation but nothing as to the influence of temperature on the quality of the radiation Here however the effect was even more marked than it was on the quantity By quality of radiation was meant he proceeded the character of the spectrum of the radiant energy If such energy were allowed to pass through a rock salt prism which was transparent to most kinds of radiation a spectrum was produced If the radiation proceeded from a very hot body such as the



Curve Showing the Distribution of Energy in a Spectrum Wave Lengths are Plotted as Abscissæ From Left to Right Energy Vertically Upward as Ordinates Note the Very Abrupt Falling off For the Short Wave Lengths

lime in the lime light a certain amount of the spectrum would be visible to the eye which could see a certain distance towards the red end of the spectrum and also for a certain distance towards the violet In the case taken however this visible portion was a very minute fraction of the whole radiation In fact the visible spectrum covered only about one octave the longest wave-lengths visible being 0 7 μ and the shortest about 0 4 μ where μ represented $\frac{1}{1000}$ millimeter On the other hand Rubens and Woods had recently demonstrated the existence of waves having a length equal to 108 μ—that was to say comparable with $\frac{1}{10}$ millimetre—and there was no reason to believe that this was a limiting value Probably indeed a hot body sent out radiations the wave-lengths of which extended to infinity in both directions It was interesting he said, to determine the distribution of energy in such a spectrum This could be done by moving



Curves Showing Energy Distribution in Light From Different Sources Only Radiation to the Left of the Dotted Line is Visible Note That *all* the Radiation From the Fire Fly is Visible But Only a Very Small Proportion of the Light From All Other Sources

a very fine platinum wire from point to point of the spectrum and then measuring electrically the temperature it acquired at each point This procedure gave an indication of the energy distribution and if the results were plotted against wave lengths as abscissæ a curve such as that indicated in Fig 1 was obtained in which the verticals were proportional to the energy of the *radiation of corresponding* wave length This reached a maximum at a particular value of the wave length and as would be seen the curve tumbled down from this maximum extremely rapidly on the side of the shorter wave lengths Curves such as the foregoing drawn for a number of radiating bodies were all similar in character but the position of the maximum ordinate moved very rapidly toward the side of shorter wave-length as the temperature rose The wave-length of maximum energy the speaker continued was connected with the temperature of the radiating body by the following equation

$$\lambda max\ \theta = 2940$$

where λmax denoted the wave length in μ and θ *the absolute temperature in Centigrade degrees*

Thus for the sun which had an absolute temperature of about 6 000 deg the wave-length of maximum energy was about ½ μ which lay in the yellowish green part of the spectrum At 16 deg C or 289 deg absolute the equation gave λmax = 10 μ nearly which was far beyond the visible portion of the spectrum the limit of which on the red side was about 0 75 μ corresponding to a dull crimson Hence increasing the absolute temperature from that of the lecture room to that of the sun shifted the wave-length of maximum energy from 10 μ to ½ μ

The relative amount of energy in different parts of the spectrum Sir Joseph continued varied more rapidly with change of temperature than did the total energy *If* the temperature of a body were raised from 300 deg absolute to 600 deg absolute (which was just below the limit of visibility) the total radiation would be multiplied by 16 but it by no means followed that the energy of each constituent of the spectrum was increased in the same ratio In fact by such a rise of temperature the energy in certain of the very short wave-lengths was multiplied by millions and in brief the multiplier was extraordinarily different in different parts of the spectrum

It was interesting the speaker continued, to note the abrupt fashion in which the energy curve tumbled down on the side of the shorter wave-lengths, and to exhibit this more strikingly he had prepared the following table showing the proportion of the total energy which lay to the left of the spectrum, having 1 8 μ as the wave-length of maximum energy

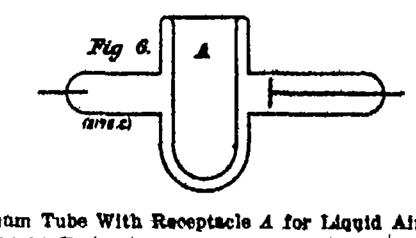
Wave-Length λ.	Energy in Waves Shorter than λ.
$\lambda_{max} = 1\ 8\ \mu$	$\frac{1}{4}$
$\frac{1}{2}\ \lambda_{max.}$	$\frac{1}{100}$
$\frac{1}{4}\ \lambda_{max}$	$\frac{1}{5000}$
$\frac{1}{10}\ \lambda_{max}$	$\frac{1}{1\,000\,000}$

Referring again to Fig 1 it would, the speaker continued be seen that by far the larger proportion of the energy lay on the side of the larger wave-lengths At higher temperatures however, the proportion of energy in the visible spectrum and on the ultra-violet side increased as was shown by the following figures

Absolute Temperature deg Cent	Proportionate Energy Lying Beyond λ = 0.7 μ	Proportionate Energy Lying Beyond λ = 0.5 μ
1500	$\frac{1}{15\,000}$	$\frac{1}{3\,000\,000}$
2000	$\frac{1}{100}$	$\frac{1}{125\,000}$
2500	$\frac{1}{37}$	$\frac{1}{163}$
3000	$\frac{1}{11}$	$\frac{1}{31}$
4000	$\frac{1}{3}$	$\frac{1}{13}$

It followed therefore that, in using an incandescent lamp with a filament at 1 500 only about $\frac{1}{15\,000}$ part of the total energy supplied was utilized as light the remainder being spent in heating up the bulb of the lamp If the filament were raised to 2 000 deg absolute then the energy lying on the short-wave side of the extreme red was 1 in 100 and 1 part in 13 000 lay beyond the yellowish green to which the eye was most sensitive With a temperature of 3 000 deg absolute one part in eleven of the total energy lay in the visible spectrum and when the temperature was 4 000 deg absolute nearly one-third of the energy lay to the left of the red extremity of the visible spectrum and one-thirteenth in the portion most useful for vision Thus with low temperature sources of radiation only about $\frac{1}{10\,000}$ of the energy was usefully applied with the carbon arc on the other hand having a temperature of about 4 000 deg nearly one-third was utilized It was on account of the higher temperature at which they could be run that metallic filament lamps were so much more efficient than the carbon filament lamps With the latter having a temperature of about 2 000 deg absolute only about 1 per cent of the energy served to produce light

To illustrate the small correlation between the total amount of energy radiated and amount utilizable for purposes of vision the lecturer next placed a thermopile between a limelight and a red hot ball each source heating an opposite face of the instrument He showed that in the conditions of the experiment the thermopile indicated that it received equal heat from the two sources when about midway between them Substituting then a photometer for the thermopile he showed that it was impossible under any condition to get a balance between the light from the ball and that from the limelight No matter how close the photometer was moved to the ball the side exposed to the limelight was always much the brightest showing that as a light producer the limelight was enormously the more efficient of the two radiators.



Vacuum Tube With Receptacle *A* for Liquid Air The Light Emitted is in no way Diminished by This Intense Cooling.

The temperature at which radiation first affected the eye was he said a matter of considerable interest No matter how carefully one might prepare the eye by previous sojourn in a dark room it was impossible to perceive by it any radiation from a body at the temperature of boiling water If the temperature were gradually raised, however, there came a stage pretty much the same for all bodies, and within narrow limits for all individuals, at which light was perceived All agreed that this first perception was not red though the sensation was differently described by different people. His own view was that this first

* Report taken from *Engineering*

perceivable radiation was not a color sensation at all in the sense in which we got colors at higher temperatures If the experiment were tried it would be noticed that the light was best seen when the source was looked at not directly but out of the corner of the eye. This circumstance he thought, gave a clue to what the nature of the first impression really was. In the retina there were two sets of structures—viz rods and cones—the latter being concerned in the sensation of color The rods apparently were affected by radiation slightly before the cones Hence the first effect of radiation as the temperature rose was on the rods only the impulse being insufficient to affect the cones. This explained why this first perception of light was best seen out of the corner of the eye In normal conditions the eye naturally focussed for the 'yellow spot which was the part most sensitive to color and consisted almost wholly of cones Thus if the rods were first affected the eye ought to perceive the radiation with the rods and not with the cones and the image should therefore be formed on the retina at a point where the rods were more plentiful and not on the yellow spot Evidently it would follow that animals which saw in the dark should cultivate rods rather than cones, and his zoologist friends informed him that the eye of the owl was remarkable for the extremely great proportion of rods as compared with cones Probably the owl might not in a faint light see any distinct color but it saw something good enough for its own purposes where ordinary mortals would see nothing

The sensitiveness of the eye to different colors the lecturer proceeded varied in a most extraordinary way Langley had made an estimate of the energy required to excite various color sensations Taking as unity the energy required to excite the sensation of a dull crimson red then $\frac{1}{100000}$ of this amount would suffice for the yellowish green It was remarkable that the sensitiveness of the eye to light was greatest for the wave length of maximum energy in the solar spectrum It would he said be interesting were it possible, to investigate whether the eyes of such animals as had remained unaltered for long geological periods had a maximum of sensitiveness to the light of the same color as we had If the sun s temperature had changed within the geological period covered by the life-history of such organisms it was possible that the latter would prove to have a maximum of sensitiveness for some color other than the yellowish green From the table already given above it would he continued be seen that the energy radiated from most incandescent bodies lay nearly all in the non luminous portion of the spectrum In the case of the arc light nine tenths of the energy supplied and paid for was wasted The ideal to aim at in illumination was the production of radiation confined to the color to which the eye was most sensitive Engineers had not yet succeeded in doing this but there were certain lowly animals which had solved the problem for themselves the firefly for example producing light most efficiently

The spectrum of the firefly had first been investigated by Langley whose results were very remarkable He had given the diagrams Figs 2 to 5 showing the amounts of total and of useful energy radiated from different sources Of these Fig 2 represented the energy distribution in the spectrum from a gas flame the useful portion of the energy lying to the left of the dotted vertical In the case of the firefly it would be seen that every bit of the energy radiated lay in the proper place nothing being wasted either in the production of heat or of ultra violet rays It seemed therefore that the future of lighting might lie in the finding of some substance capable when suitably excited of producing light like the glow worms without the expenditure of energy in long waves

That heat was not a necessary concomitant of light could he continued be shown by the following experiment The apparatus (Fig 6) used was a vacuum tube having a receptacle for liquid air formed in it at A On exciting this tube Prof Thomson showed that filling the cup A with liquid air in no way affected the production of the light There was no dark space formed near the walls of the cup though the temperature there must have been very little above that of the liquid air

The sensitiveness of the eye to small amounts of energy was the lecturer continued exceedingly remarkable In the greenish yellow the expenditure of $\frac{1}{100000000}$ of an erg could be distinguished by the eye If vision were due in the first place to chemical changes produced by the light it could be shown if these changes were of the same order as those to which we were accustomed in the laboratory that the amount of matter decomposed by this amount of energy could not exceed a few thousand individual molecules The eye must therefore be extraordinarily efficient in detecting chemical changes if this were actually what it did do in the act of seeing On the other hand others held that chemical actions were not involved but that in the eye there were systems capable of taking up any kind of vibration and being set into resonance by it If the action were primarily chemical the fact that the changes were produced only by light of short wave length constituted a difficulty There was however one view of light on which this difficulty would not arise and this was coming into favor with many physicists who held that radiation was built up of a number of different units of energy somewhat resembling the particles in the old corpuscular theory The energy of the light was concentrated into these individual units the amount in each unit being more the shorter the wave-length of the light If this were so it would be easy to understand how it was that chemical action was excited by light of short wave length only If the change in question required more energy than an individual unit contained it would not be effected and as the units corresponding to the shorter wave lengths contained the most energy it was with these that chemical activity should be associated

(To be continued)

A New System of Perforating Metal

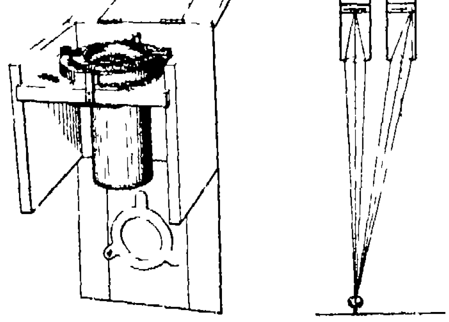
Andrew Smith's Improvement

A FEW years ago Andrew Smith a mechanical engineer of San Mateo California had under his supervision the construction of a number of water wells It was found by him in common with all engineers that the difficulty of using the ordinary well casing was almost insurmountable A number of attempts to improve the methods of making perforated casing were made by him the object being directed to get a definite water area through the use of inner and outer slotted tubes These attempts were governed to the well-established rule that sheet metal cannot be punched with a punch narrower than the thickness of the metal These tubes were so placed as to provide openings sufficiently small to prevent the ingress of fine sand and silt While this was a distinct advance in the art of constructing water well casings the results were not fully satisfactory to the experimenter for he felt that the same result should be obtained with a single tube casing

Further experimentation proved that an entirely new process of perforating metal had been developed and that by this process sheet steel one-half an inch thick could be perforated with slots one thousandth of an inch wide by any desired length or that a slot of any desired width could be made While developing the new process of perforating metal most of the leading metal perforating establishments in the United States were consulted Some went so far as to say that the feat was impossible others that it was impracticable while still others stated that the inquirer was wasting time in trying to solve the problem

The invention in common with many other important discoveries is very simple when it is known how it is done The old way of cracking the metal with a sharp chisel to make slots narrower than the thickness of the metal left rough jagged openings and bulged the metal outwardly This outwardly bulged metal was exposed to corrosions and made the casings difficult to drive because of the great resistance of the projections The first attempt made by Mr Smith to obtain a casing with slots of the required width resulted in a clean-cut shear by depressing one edge of the metal a little more than its thickness thereof, thus producing a smooth opening not at all like the old cracked perforation This style of perforated metal can be used, for example in shallow water wells, drain tiling or irrigating pipes

The step having been taken and the sheet actually sheared to produce the given slots, the next step was to make a clean-cut shear by depressing the sheet metal in opposite directions on each side of the slot to be produced thus reducing the distortion of a given portion of the metal sheet After being so sheared the projecting lips can be cut again or upset to make an opening of any desired size whereupon the projecting lips may be rolled back into the plane of the sheet leaving it perfectly smooth It is also possible to produce openings by making a clean



A COMPASS FOR BALLOONS

cut shear first and then rolling the projecting portions back into the plane of the sheet the uncut portions between series of slots being rolled enough to stretch the metal to make the openings This latter process is the most ingenious part of the new invention for the reason that the perforating can be done by having suitable dies in rolls or in a gang punch ing machine As soon as the plate has been passed through the rolls or gang punch the sheet may be passed through another set of rolls which rolls the lips back into place and stretches the metal the proper amount

This process does away with the use of fine saws fine milling or fine punches such as were required by the old processes and results in saving considerable money for tools alone since each tool used is very strong and withstands an enormous amount of wear

Two of the most important uses for this perforated metal lie in the water and oil well casing fields The first requires a very fine casing to prevent sand from passing into the well and the latter requires a very strong and heavy casing to prevent injury thereto each of which conditions may be adequately met by this process

Another form of the casing is produced by depressing the casing with a sufficiently large punch to form a clean cut shear after which one edge of the depressed lip is cut at an angle to the first cut so that when the metal is returned to the general plane of the plate a V shaped slot is formed The advantage of such fine V shaped perforations cannot be over-estimated Where the oil or water sands are struck the gas oil or water enters the perforations at once and therefore equalizes the pressure and prevents the sands from heaving up in the casing When the casing has been put down the required depth the well casing itself acts as a strainer and it retains at the narrowest portion of the V shaped slots all fine material any material passing into the casing not being retained by said slots since the narrowest portion is at the outer circumference thereof Such a casing has more than ten times the capacity of the old cracked casing and it is much stronger for the reason that the metal is not broken transversely to the slots formed

A Compass for Balloons

DR. BESTELMEYER has invented a compass by which the direction and velocity of a balloon s flight can be determined in a very convenient and practical manner A transparent compass card with its needle is attached between two glass plates to the top of a wide aluminium tube which is swung on gimbals in the usual manner The lower end of the tube carries a lens by which an inverted image of the landscape is thrown on the compass card When the balloon is moving in any given horizontal direction the image of every point of the landscape moves across the compass card in the same direction as is shown in the diagram The pilot selects a point of the landscape which passes exactly under the center of the card and notes the point of the compass at which it leaves the circumference This observation gives the direction of the balloon s course The horizontal velocity of the balloon is determined by measuring with a stop-watch the time occupied by a point of the landscape in moving from the center of the compass card to the circumference of a circle of one centimeter radius which is inscribed on the card From this interval in combination with the height of the balloon obtained by other observations the velocity of the balloon is obtained by reference to a table

Alloy for Stuffing Boxes (also for faucet plugs) — Copper 86 2 parts, tin 10 2 parts zinc 3 6 parts

Romanized Typewriter Type

By Jacob Backes

It is part of every business education imparted with thoroughness on modern lines to learn how to produce or at any rate how are produced through the agency of several imitative processes facsimile and form letters which when filled in with names and addresses on a real typewriting machine with matching ribbon and skillful manipulation may serve the purpose of giving to each of the unsuspecting recipients of the letters the idea that the communication was directed to him only

On the other hand the ability to quickly discern the really and individually typewritten letter in the morning mail is also a very useful part of that same kind of modern education

A well executed form letter is in a way a flower of applied knowledge The grammar spelling diction and general politesse of the average form" letters are distinctly better than those of the average individually written letter No form letter coming to the notice of the writer ever contained offense in the lines or between them

The increase in the fac-simile expert s ability to create simulative favors and the antagonistic development in the mail clerk of those apprehending faculties by the exercise of which such productions may be immediately recognized are comparable to the increasing size and projective force of modern missiles of destruction which step by step bear a certain and unmistakable relation to the improvement in the processes or appliances by which munizers are created or defensive armor is thickened and toughened

Recent developments in typewriter technique and performance threaten still further complications The army which makes use of the machine has literally become millioned and astute manufacturers have found that among this array of users are many typists unable to summon enthusiasm for the conventional pattern and apparence of typewriter characters These particularists existing and vociferous from the very advent of the machine have become numerous enough to be regarded by powerful typewriter organizations as worthy of special catering Result an output and increasing sale of machines equipped with types -variantly trade known as Imperial Clarendon Printype so fairly simulating customary printers typographical outlines and shadings that recipients oftentimes—so experience has proved have without perusal thrown away letters typed with such characters under the impression that they were common printed circulars

It certainly is food for thought that the better the wording arrangement and layout of a letter is and the more correctly and smoothly it is typed the more likely is it to look like a form letter and to

outside of their employment, and they have se
invented in the typewriter line. I have figure
clined to think that I would not come up to yc
calue I was given to understand that the Fil
typewriter to compete in the general field of t
it up, if they secured the right machine. They
one especially for them, but I never had any l
do not think it is in him. If the machine you c
could satisfy such a concern as that that you

Courtesy of Chester W Brown

TYPEWRITER WORK IMITATING PRINTED CHARACTERS ONE OF THE EARLY ATTEMPTS

be mistaken for one especially when it is sent to or received from a stranger This truth has so wrought on some who have felt aggrieved at finding themselves taken in by imitators that it has been suggested each writer of genuine letters should send an affidavit of genuineness to accompany his communication or that some other device be introduced whose attachment to or appearance in a letter would purport a guarantee of freedom from the taint of form or facsim

The linotype machines which set the type for most of the great publications of civilization can be provided with matrices and adjustments by which lines with all the well known characteristics of typewriting may be cast at will

For several years type founders have been making type in 6 8 10 and 12-point sizes, well imitating, both in actual size and miniature, the genuine machined production and selling this type to printers with edifying instructions as to how the imitative intent may be carried to successful achievement Here are il-

This sample is a fac-simile
of the work done on one of the
typewriting machines equipped
with types devised in the en-
deavor to successfully imitate
the conventional Roman forms
The effect of light and shaded
lines is obtained, though all
the characters--the same as in
more ordinary typewriting--are
made on equal width, so that
the carriage will travel just
as far on the striking of an l
as on the striking of an R

A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z a b c d
e f g h i j k l m n o p q r s
t u v w x y z 1 2 3 4 5 6 7 8
9 0 ½ ¼ ⅜ ⅝ ⅞ ⅞ " # $ % _ &
' ( ) , ? @ , . /

Sample of Typewriter "Roman".

SAMPLE SHOWING HOW THE TYPEWRITER CAN IMITATE PRINTED CHARACTERS THE LATEST ADVANCE

luminative citations from a circular

Messrs Ambitious Printers

The work of typewriters using large type is closely imitated by using our 12 point new model ——— ——— No 3 There are hundreds of job presses running constantly on this typewriter work in the large cities The rapid increase in the mail order business and use of follow up systems has created an enormous demand for this work and no hustling printer can afford to overlook this source of profit

This is our new model ——— ——— No 3 printed through silk All our typewriter faces are made from dies furnished by the makers of the typewriter and duplicate the typewritten work If you wish to match the work of any typewriter not mentioned here send us a sample and we can undoubtedly furnish the type you want

If the addresses are to be filled in on a typewriter have the strenographer write a sample letter Use this as a color sheet and have the pressman work to it You can vary the depth of color on the press and not on the typewriter Hence the pressman must work to the typewritten sheet When addresses are not inserted this typewritten color sheet is not necessary etc

A few specimens are herewith shown of what has been and is being accomplished by peculiar typewriting contrivances It is seen that so well do printers imitate typewriting and so well can typewriting be done to imitate printing that any distinction which may have formerly existed between printers characters and epistolary type has been submerged in the rising tide of imitation

Incorrect notions are abroad of the versatility with which the genius of the manufacturer has endowed and will further continue to endow typewriter mechanisms In times past with the scarcer population and relatively little appreciation or understanding of mechanographical latencies it was enough to make machines of limited range of performance and severe typographical restrictions At present there is a universal market for them and a legion of critical yet appreciative users which legion is divided and subdivided and yet again into sections requiring special things to be done and in a special way and to these purchasing divisions each larger than the integer of not many years ago the keen-sighted inventor finds it profitable to turn observant eyes

Elephant Domestication in Africa

While elephants are trained and commonly used for various purposes in Asia it appears that in Africa there is as yet but little attention paid to this question Some points about elephants in Africa and the great need of employing them so as to obtain a valuable aid have been brought out by Capt. Devedeix, a French cavalry officer, commanding the native troops of the Chari Tchad region. With forty-two of the cavalry he made a brilliant raid in the Ouadai region not long since and is well able to speak about the present subject. How to supply the French troops of the Lake Tchad and Ouadai regions is becoming a very important question, and he proposes to use the African elephants for this purpose so as to replace the native carriers Such work is very trying for the natives and often shortens their life, so that humane reasons are one of the points in favor of this.

Besides this reason there are somewhat numerous advantages to be gained by training elephants for domestic work It is estimated that at present the number of elephants in Africa is 300 000 or 400,000, but it must not be forgotten that we are exterminating 50,000 every year so that before many years the elephant will become extinct, like the American bison for in the case of the elephant, its reproduction is far from keeping pace with the great slaughter of these animals which is now going on It is likely that different regulations will be made in the future to try to stop this rapid killing off of the African elephant and in fact some such decrees have already been issued in this country showing that attention is being awakened to conditions. Special societies are even formed for preserving the elephant. Capt. Devedeix thinks that the example of Asia should be followed and there is no reason why the elephants should not be trained so as to give a very good means of transport especially as this is very much needed in the Congo region which is the part of Africa under consideration at present In this country the imported pack animals die off rapidly from marsh fever or lack of proper care But the elephant is well adapted to replace pack horses or mules, by reason of its being accustomed to the climate and besides its very long life of over a hundred years Its force is ten times as great as the strongest of the other animals and the remarkable intelligence of the elephant is proverbial Not only can it be used for carrying loads but at the same time it opens up routes through the dense forests

In the Belgian part of Congo steps have been already made toward training elephants and the first work of the kind is carried out at the recently opened elephant farm at Appi where there are fifty or more elephants now and many more are to be added before long The idea is due to a French officer in the first place but it was the Belgian government which took the first steps to laying out an elephant farm on a large scale in the Congo under Com Laplume At present the fifty elephants are well domesticated and are used for cultivating the

This was written on a machine
with which words can be mechan-
ically separated by a half space
or any multiple thereof, instead
of by a full space or a multiple
thereof, as ordinarily All
words here are separated by half
spaces. What is ordinarily an
m is broadened into an m by writ-
ing an n a half space after an-
other n, and the W and the w are
broadened into W and w by strik-
ing a V or a v half a space after
another. Note the width of the
m and the w throughout this par-
agraph, and the unusually short
distance between the words.

Courtesy of A A Clarke

A PRINTED APPEARANCE IS PRODUCED BY USING A SPECIAL NARROW SPACING BETWEEN WORDS

soil drawing wagons or carrying loads. Not long ago the first long trip across the country was made by one of the teams belonging to the farm, composed of eight animals and they covered more than 400 miles, returning home in very good condition. In order to proceed with training a greater number of animals, it was decided to send experts to India and Ceylon so as to observe the methods of capture and domestication which are used there. After this it is intended to begin, not only with young elephants, but also with adults as well The elephant is still abundant in the Congo region and in the neighborhood of Lake Tchad, and owing to the increasing needs of transportation it is desirable that some more be made toward establishing elephant farms in many places and on a large scale, as there [illegible]

[illegible] African region should be deprived of the [illegible] services rendered by these animals such as [illegible] so strikingly in India.

This condition of things is especially true in the regions where there are no railroads and such could only be built at an enormous cost and even pack animals are lacking. Native porters are all that is to be seen in such regions for carrying loads and supplying the troops Besides should elephants be used the natives would be free to take up agricul ture for which there is need of labor at present Again the natives themselves would soon be led to domesticate the animals stimulated by the high prices which wo ild be offered For instance an elephant when killed does not bring more than $60 or $80 while as in India the value of a trained animal is no less than $800 to $1 000 After this it remains to domesticate other African animals especially the zebu and also the hippopotamus which is now em ployed on rice plantations in other countries as well as the ostrich and the antelope

The Morane Monoplane

Scale Drawings of the Machine that Won the Paris-Madrid Race

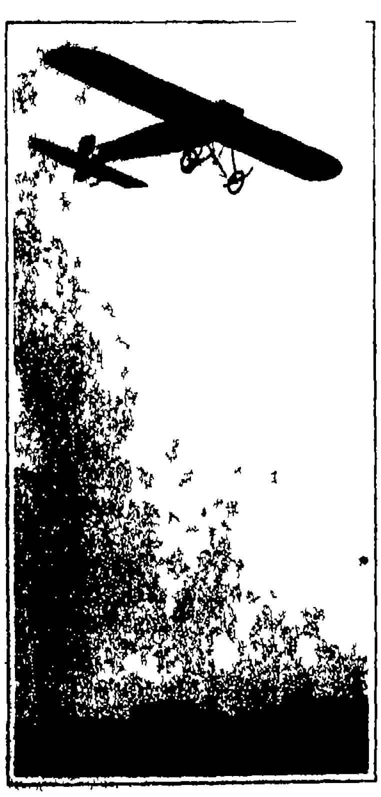
By John Jay Ide

One of the most successful aeroplanes which have made their appearance recently is the Morane mono plane This machine was designed by Leon Morane in collaboration with Ralph Saulnier formerly as sociated with Louis Blériot Morane first appeared

VEDRINES THE WINNER OF THE PARIS MADRID RACE AT 60 MILES AN HOUR

in the public eye last summer at Reims where he broke the world s records for five ten and twenty kilometers with the 100 horse power Blériot XI bis *type de course* He also drove one of the Blé iot XI bis two-seaters which made their debut a few weeks previously He used this same achine at Bourne mouth and it was with a similar model equipped with a 100 horse power motor that he and his brother made their disastrous attempt last October to win the Paris-Puy de Dôme prize Thus ended Morai e s ex perience with the Blériot machine

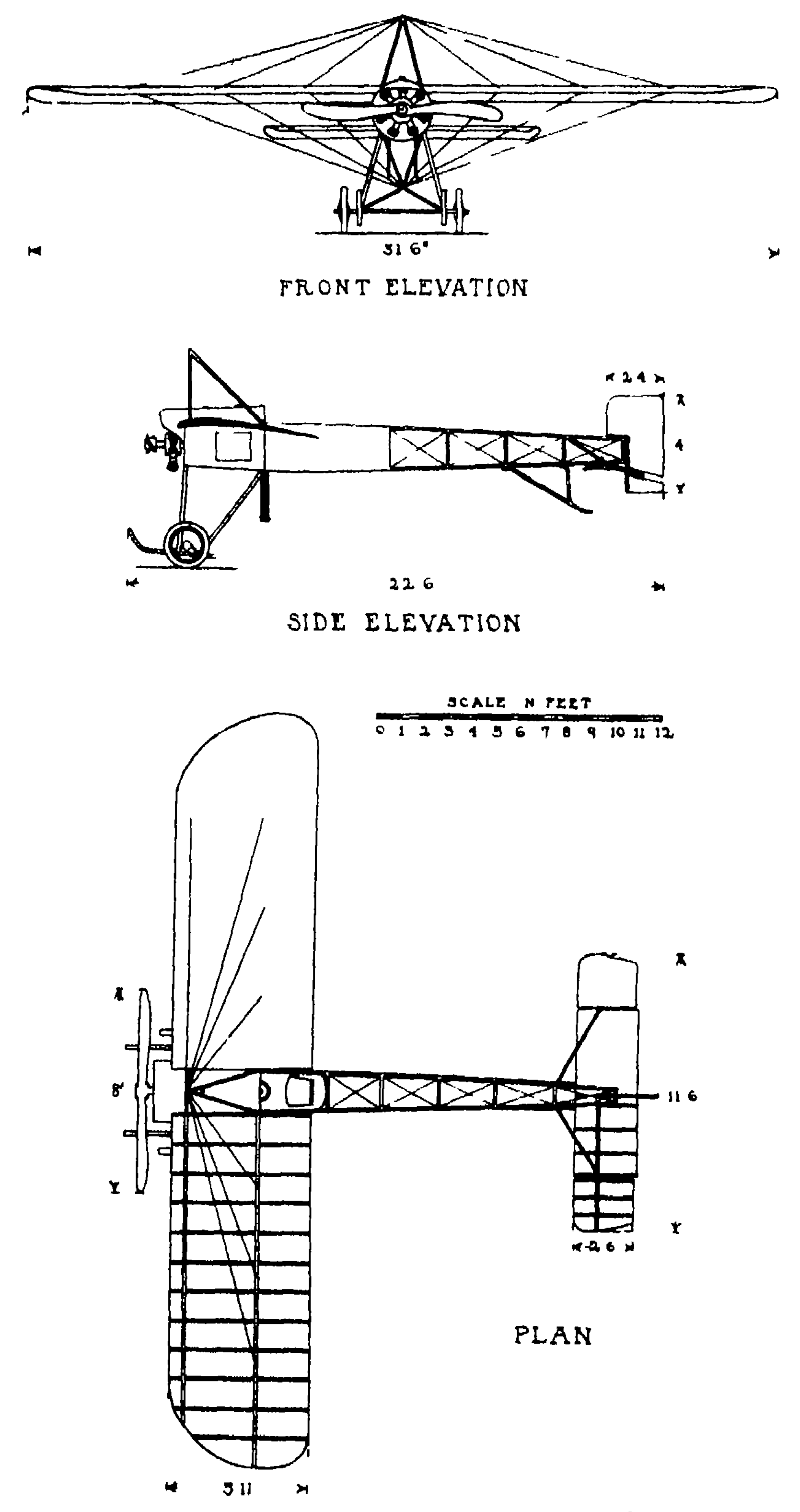
While prevented from flying as a result of his acci



VEDRINES IN FLIGHT

dent, Morane with the aid of M Saulnier designed a monoplane which although broadly resembling the Blériot, has several original features One of the essential points of difference between the two machines is the landing chassis In the Morane the chassis consists of two very short skids curved up in front so as to protect the tractor screw and joined solidly to the fuselage by four main struts. By means of rubber rings the skids are joined to the axle, which carries the two wheels placed five feet three inches apart The total weight of the undercarriage is only forty two pounds and yet its strength may be realized by the fact that it has repeatedly withstood the shock of landing on l ad ground at speeds of over eighty miles an hour with the wind

A further difference between the Blériot and he Morane is in the entire suppression of the dihedral angle between the wings of the latter This has been done with a view to obtaining increased speed For the same purpose the wings have been made very flat on the underside and the point of maximum camber is very near the leading edge It will also be noticed that the shape of the extremities of the wings has been radically altered. The mast carrying the upper wing stays is pyramidal and so arranged that t e support at he front is more at right angles to the wings and so bet er protects the spars from over stress The rudder is divided into two sections by t e stabilizing tail j s forward of which is he light double skid



SCALE DRAWINGS OF THE MORANE MONOPLANE

With a view to re lucing wind resistance part of t e fuselage which is quadrangular in section has been covered in with fabric The pilot sits behind a long bonnet inclosing the tanks and extending over the engine By this means he is protected from the spray of oil incidental to the employment of a re volving motor which in this case is a 50 horse power Gnome driving a Chauvière Intégrale tractor screw eight feet in diameter and five feet eleven inches in pitch At 1 100 revolutions per minute this

combination has driven the machine at a speed of seventy miles an hour officially timed on a closed circuit

The leading dimensions are as follows Span 31 feet 6 inches length 22 feet 6 inches The total carrying surface is 188 square feet of which 151 are accounted for by the wings the remaining 37 being in the stabilizing tail The machine weighs 440 pounds empty which shows with what great care the question of lightness has been studied moreover this result has not been reached at the expense of strength and from the point of view of solidity the Morane monoplane can compare with any

When the Morane was first brought out Aubrun was taken over from Blériot and became the chief pilot When he left to join the Deperdussin firm Pierre Védrines was selected to fill the position Védrines had been chief mechanic to Mr Robert Loraine the actor aviator and later had distinguished himself by some fine cross country flights on a Goupy biplane On becoming chief pilot of the Morane Védrines promptly did some more cross country work flying from Pau to Toulouse Carcassone and other places in the south of France where hitherto little or no flying had been seen Late in March he set out to fly from Paris to Pau but got lost in a fog On the 30th of the month he did the famous Poitiers Paris trip of 210 miles in two hours and twelve minutes at a speed of over ninety miles per hour with a twenty-mile wind It was this feat which first brought the Morane to the attention of the American public On April 22nd Védrines made another attempt on the Paris Pau prize and this time he succeeded in winning it He covered the course of 500 miles in three stages His actual flying time was six hours and fifty five minutes which gives a speed of 72 28 miles an hour

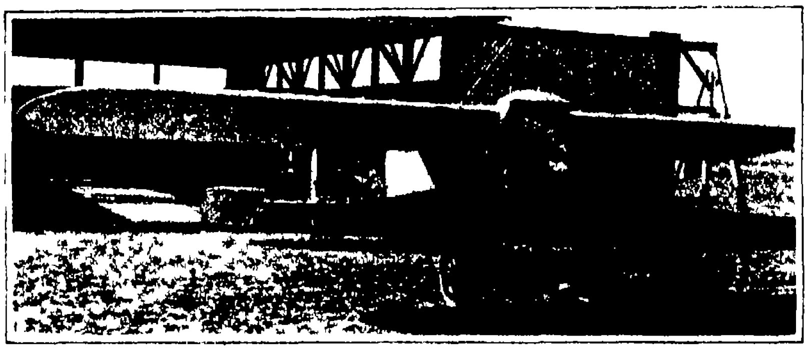
The above flights were however completely over shadowed by the wonderful performance of the Morane in the Paris Madrid race which started on May 21st under such tragic circumstances Védrines who left Paris the day after the start won the first stage Paris Angoulême the second stage Angoulême San Sebastian and was the only entrant to reach Madrid thus winning the prize of $20 000 offered by Le Petit Parisien

In the Paris Rome Turin race three Morane monoplanes were entered Two of them one driven by Vedrines and the other by Caget quit the race Andre Frey however continued He started from the aerodrome at Buc on May 28th and arrived at Dijon (16_ miles) the reporting station at 7 11 o clock in the evening He resumed his course at 4 16 A M toward Lyons arriving there at 7 43 A M covering the distance of 108½ miles in 3 hours 27 minutes At 8 45 he started again for Avignon (127 miles south) which place he reached at 12 05 o clock P M on the 29th He left Avignon at 5 35 A M arriving at Genoa shortly after 6 o clock on the 30th—requiring 12 hours 45 minutes time

On May 31st Frey left Genoa with high hopes of overtaking the leaders But in this he was not successful At Pisa he mistook a racecourse decorated with flags for the San Rossare aerodrome and he landed so heavily that the machine turned complete somersaults and was so badly damaged that Frey had to send for a new one from Paris Frey arrived in Rome on June 7th

On Tuesday June 13th the German aviator set out to complete the last leg of the journey He was warned against the attempt but paid no heed to warning and started out in spite of the fact that other competitors who had intended to start also withdrew on account of a threatening sky When but a short distance from Rome he encountered heavy fog that confused him and soon lost his way sailing into a terrific storm of rain wind and hail He endeavored to ascend above the clouds but his machine refused to rise and suddenly and unexpectedly it swooped downward all control of it being lost by Frey He was in the mountainous country between Viterbo and Rome when his aeroplane fell into a ravine, burying him under the debris. The fact that he wore a heavy helmet saved him from a gruesome, instantaneous death and the fact that he landed on soft marshy ground His arms and left leg were broken and his face badly cut

A number of searching parties set out to find him including the Passionist monks from the monastery on Monte Fogliana who know every foot of the mountainous country Also a number of reporters at the Camorra trial formed a party in search for him He was found by the Red Cross searchers in an unconscious condition under the debris of his machine



FRONT VIEW OF MORANE MONOPLANE FITTED WITH A GNOME MOTOR

Cold Storage

By H E Barnard

The preservation of food stuffs so that the surplus created during seasons of plenty could be distributed throughout the year and the fresh products of one country shipped to another was at one time impossible The use of chemical preservatives which arrested decomposition served in a measure to supply the need but this doubtful method of retarding the natural spoilage of foodstuffs has given way almost entirely with the development of methods of refrigeration which make it possible for foods of every character to be placed in cold storage and there held for considerable periods without apparent change in composition or structure Cold storage is simply the placing of foodstuffs in rooms kept at a sufficiently low temperature to hold the goods in normal condition until such time as these are needed for consumption This temperature varies from a point several degrees above freezing to zero and below Certain goods such as fruits which can not well be frozen can be kept without any spoilage for months at a temperature of about 34 deg F while butter and meats are stored at a temperature ranging from below zero to freezing Poultry is usually stored at a temperature varying from 0—25 degrees Cheese supposed by manufacturers to cure or ripen in storage is usually held at a temperature slightly above freezing Cold storage at suitable temperatures undoubtedly improves certain foodstuffs up to a certain point This is especially true in the case of fresh meats poultry and fruits Other products do not improve in storage and after a time begin to deteriorate even when kept at temperatures which inhibit to a large extent the ordinary processes of fermentation and decay

The investigations of the United States Department of Agriculture on the effect of cold storage on eggs poultry and game have been carefully worked out and have developed much data which throw a new light upon the results of storage at low temperatures In general the results of the studies show that cold storage when properly used is a very valuable improvement in the methods of the conservation and distribution of the food supply and that the term cold storage as applied to foods is in no sense a mark of inferiority or low grade

It is true that time limits are well established beyond which goods should not be kept in storage and that if such foods as eggs fish or poultry are held for a longer period deterioration at first slight and later marked takes place But such time limits are sufficiently long to carry the products until the natural season of scarcity is past and in fact carrying charges insurance and interest on the money invested does not except under most unusual conditions make it profitable for the warehouse men to hold goods longer

Food prices have been advancing rapidly and in part at least this has been attributed to the increasing practice of holding foodstuffs in storage and because of this fact as well as because of the impression that they are of poor quality cold storage foods are viewed with disfavor by the consumer This feeling coupled with the constantly increasing tendency to throw additional safeguards around the food supply has prompted the introduction of cold-storage bills in many of the State legislatures In one State at least, namely Indiana, such a bill has been enacted into law The bills up for consideration in the various States vary widely in character and on the whole show a great lack of information as to the purpose and practices of cold storage. In some measures the time limit placed upon the storage of foodstuffs is so short that the passage of such a law would demoralize the produce business and instead of reducing prices on food stuffs would bing a return of former conditions of plenty during the season and scarcity throughout the rest of the year

The Indiana statute is entitled "An Act for the protection of the public health and the prevention of fraud and deception by regulating cold storage and refrigerating warehouses, the holding of food products stored therein and the sale of such products.' It requires that foodstuffs which are entered into cold storage shall be marked with the date of entry and that when withdrawn for sale they shall show the date of removal. All foods products placed in cold storage shall be withdrawn at the end of nine months. It is provided however that such goods shall be subject to inspection as to their sanitary condition and that if the goods are found unfit for food they shall be destroyed The authorities are furthermore instructed to condemn and close any warehouse which is not kept in a sanitary conditions This measure does not discriminate against cold storage goods in favor of goods which have been so kept but it does provide that the purchaser of eggs poultry or meat may know how long the goods have been in storage Another section providing that the warehouse records shall be subject to inspection and so making it possible to determine the amount of goods held in storage will have a tendency to regulate the too frequent practice of speculation in the food supply

During the past year foodstuffs notably eggs and meat have commanded very high prices although there was in cold storage an adequate supply of both products. The fact that the owners of much of these goods were obliged to sell at a loss and in many instances were driven into bankruptcy at the close of the season does in no way compensate the consumer, who during most of the months of the year paid high prices for foodstuffs although following the break in prices they for a short time were sold below their actual value

Cold storage is necessary to the conservation of food products It is to be hoped that the public will learn to appreciate more than now its value It should be regulated by practical laws which do not have for their purpose the destruction of the business but which are intended rather to put a stop to the practice of storing foods which are not suitable for refrigeration but which have even before entry into storage deteriorated or become unfit for food and to assure the withdrawal of all goods before they have been held sufficiently long to undergo partial spoilage Such legislation will also be of decided benefit to the cold storage industry as all products will be subject to inspection and to this extent at least the quality of cold storage foods will be guaranteed to the consumer

Snow's Radioactivity

Some interesting data have been gathered in France as a result of the study of the radioactivity of snow that fell at Boulogne during the past winter

It has been known for some time that newly fallen snow is radioactive but until the French scientists looked into the matter the subject was not examined closely

The investigators announce that snow quickly gathered after its descent to the earth is highly radioactive Radioactivity disappears almost entirely after the lapse of two hours however Snow which has fallen on the soil appears to retain its radioactivity a little longer than that which has come to rest upon the roofs of buildings

French Lithographic Pencils—Take of talcum 100 parts soap 83 parts, shellac 70 parts mastic 10 parts, lamp black 10 parts The making up of this mass is effected in the same manner as described for the English pencils

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